DISSERTATION

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„Dietary Variety and Diet Quality in Austrian 6 to 15-Year-Old School Children“

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I dedicate my work to my grandfather Herbert Rohringer.

Content

List of Tables

List of Figures

List of Abbreviations

%E	Percentage of Energy
BGV	Between-Group Variety
BMI	Body Mass Index
DDS	Dietary Diversity Score
DVS	Dietary Variety Score
FAO	Food and Agriculture Organization of the United Nations
FAR	Food Adequacy Ratio
FBDG	Food Based Dietary Guidelines
FFQ	Food Frequency Questionnaire
FGA	Food Group Adequacy
FVV	Fruit and Vegetable Variety
HFD-Index	Healthy Food Diversity Index
IQR	Interquartile Range
M	Mean
MAR	Mean Adequacy Ratio
MUFA	Mono Unsaturated Fatty Acids
NAR	Nutrient Adequacy Ratio
ÖSES.kid07	Austrian Study on Nutritional Status in Children 2007
P:S ratio	Ratio of polyunsaturated and saturated fatty acid intake
PUFA	Poly Unsaturated Fatty Acids
Q	Quarter
RDA	Recommended Dietary Allowance
RFS	Recommended Food Score
r_s	Spearman Correlation Coefficient
SD	Standard Deviation
SE	Standard Error of Mean
SFA	Saturated Fatty Acids
USDA	United States Department of Agriculture
VIT	Variety Index for Toddlers
WHO	World Health Organization

1. Introduction and Objectives of the Study

Diet-related diseases contribute considerably to the global burden of disease (WHO, 2009). To detect nutritional public health problems, nutritional data has to be collected continuously (Trowbridge *et al.*, 1990). New indexes of overall diet quality are needed (Drewnowski *et al.*, 1997) in order to monitor nutrition.

A varied diet enables adequate nutrient intake (Foote *et al.*, 2004; Thiele *et al.*, 2004; Drescher *et al.*, 2007), which is confirmed by a good biochemical marker profile (Royo-Bordonada *et al.*, 2003). Varied diet was also found to be associated with positive health outcomes such as decreased cancer risk (Lucenteforte *et al.*, 2008; Garavello *et al.*, 2009), positive effects on the cardiovascular system (Wahlqvist *et al.*, 1989; Miller *et al.*, 1992) and decreased mortality (Kant *et al.*, 2000). On the other hand, a varied diet is associated with higher energy intake (McCrory *et al.*, 1999) and therefore is a potential reason for overweight and obesity.

It is widely recommended to consume a variety of foods among and within major food groups as stated in Food Based Dietary Guidelines that were developed in order to promote a healthy diet (World Health Organization Regional Office for Europe, 2003). However, variety seldom is explained further which might lead to wrong interpretations by consumers. Nevertheless, to promote a variety of foods is still considered to be a guideline that is easy to communicate.

Dietary variety has already been recognised as a valid measure of overall diet quality (Kant, 1996) and dietary variety scores have been shown to be appropriate means for easy and quick assessment of diet quality using 24-hour recalls, dietary records, or food variety checklists (Savige et al., 1997; Steyn et al., 2006). Such scores can be useful instruments for monitoring nutrition in individuals as well as in a population as "we need to know more about how to define dietary variety and assess its effect on the quality of the total diet" (Drewnowski *et al.*, 1997).

Since 1998, nutrition monitoring in Austria is implemented through the regular issuing of the Austrian Nutrition Reports. The first one was published in 1998, followed by the

2nd edition of 2003, and finally the most recent one of 2008 (Elmadfa *et al.*, 1998; Elmadfa *et al.*, 2003; Elmadfa *et al.*, 2009a). So far, no overall indicator of diet quality has been used in the Austrian Nutrition Reports, which would be especially useful when comparing diets of different population groups.

The primary aim of present study was to evaluate the diet quality with emphasize on dietary variety between food groups and within the food group of fruits and vegetables in Austrian school children. Data used in the present study were collected in the course of the project "Austrian Study on Nutritional Status in Children 2007" project as part of the Austrian Nutrition Report 2008.

The following objectives were considered:

- Describe the overall diet quality of Austrian schoolchildren. For this purpose, diet quality indexes at both nutrient and food level were generated.
- Generate indexes of dietary variety and relate dietary variety to energy and nutrient intake.
- Compare different dietary variety indexes, their associations with energy and nutrient intake, and their ability to describe the overall diet quality.

2. Literature Review

2.1 Diet quality

Diet quality can be measured based on current dietary recommendations. This can be done using three approaches: based on nutrients, based on foods, or a combination of both (Kant, 1996). Several indexes of overall diet quality have been developed using the above approaches. The following pages will describe the concepts of selected overall dietary quality indexes.

2.1.1 Nutrient-based diet indexes of overall diet quality

Madden and Yoder (Madden & Yoder, 1971) used energy and nutrient adequacy ratios which are calculated as energy or nutrient intake divided by the reference value. One of the first sources dealing with energy and nutrient adequacy ratios was published in a study by Madden and Yoder which aimed to evaluate the United States food stamp programme (Madden & Yoder, 1971). Adequacy ratios (ARs) were calculated for the following 10 parameters: energy, protein, calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin, and vitamin C. In their study, ARs were calculated at the household level. Energy AR, for example, was calculated as the "total kilocalories intake for the household during a 24-hour period divided by the adjusted RDA for energy (kilocalories)" (Madden & Yoder, 1971). In order to assess the overall impact of the food programme, further indexes were used. "Meets 10" is an index where a value of 1 was given, if the intake of all ten nutrients reached at least 67% of the Recommended Dietary Allowance (RDA). "Nutrient Sum" is the sum of all nutrients, of which intake is at least 67% of the RDA. Finally the "Mean Adequacy Ratio" (MAR) was calculated, which is the arithmetic mean of all ARs truncated at a maximum value of 1.

Using adequacy ratios and MAR to calculate an index of overall diet quality is an approach still commonly employed. Thiele and colleagues (Thiele *et al.*, 2004), for example, calculated two different indexes from adequacy ratios: a deficient index, including 30 nutrients for which minimum reference values have been defined, and an excess index, including 5 nutrients and the ratio of polyunsaturated and saturated fatty acid intake (P:S-ratio), for which maximum amounts have been defined.

2.1.2 Food-based diet quality indexes

For developing food-based diet quality indexes, intake of foods or food groups are related to recommendations for food intake such as the Food Based Dietary Guidelines (FBDG). This is mainly done either by comparing the amount of foods consumed to the recommended amounts, or by counting the number of foods or food groups consumed. The latter can be considered as dietary variety indexes, which will be discussed in detail at a later point (see section 2.2).

The Variety Index for Toddlers aged 24 to 36 months (VIT) was developed by Cox and colleagues (Cox *et al.*, 1997), based on the food groups and serving sizes given in the US Food Guide Pyramid. Serving sizes were adapted to take into account the reduced energy requirements for children aged 24 to 36 months. Intake of five food groups (bread, vegetable, fruit, dairy, and meat) were compared to the minimum recommended serving sizes. Scores for each of the five groups were averaged.

The Foods E-KINDEX (Lazarou *et al.*, 2009) includes 13 food groups or foods: bread, cereals and grain foods (excluding bread), fruit and fruit juices, vegetables, legumes, milk, fish and seafood, meat, salted and smoked meat products, sweets and snack items, soft drinks, fried food, and grilled food. Intake was assessed using a Food Frequency Questionnaire (FFQ). Response categories were never (0 times/week), sometimes (1-2 times/week), often (3-5 times/week), very often (>= 6 times/week). For each food category a score of 0-3 (except for cereals and grain foods, and sweets and snack items 0-2) was assigned (Lazarou *et al.*, 2009). High scores represent a healthy diet, low scores a poor diet.

Freisling and colleagues (2009) developed and validated the Food Frequency Index (FFI) in Austrian elderly. A 28-item FFQ was used to build the index. Three characteristics were requisite for a food item to be included in the FFI: foods had to be listed in the current food-based dietary guidelines, foods had to supply the target population with significant amounts of critical nutrients, and the intake of the foods had to be a discriminating factor from person to person. Those criteria applied to 10 out of the 28 investigated food items (pasta/rice, wholemeal bread, vegetables, fruits (fresh), pulses, almonds/peanuts/nuts, milk products, beef/pork, poultry, and processed meats) which then were used to calculate the FFI. Each food group was assigned a score from 0-7, depending on the frequency of consumption.

2.1.3 Nutrient and food based diet quality indexes

The Diet Quality Index (DQI) (Patterson *et al.*, 1994) was based on the nutrient and food intake recommendations by the Nutrition Research Council, 1989 (Committee on Diet and Health, 1989). Components of the DQI are intake of total fat, saturated fat, cholesterol, protein, sodium, and calcium, vegetable and fruit consumption, and intake of starch and other complex carbohydrates.

The DQI was modified taking into account changed dietary recommendations resulting in the DQI revised (DQI-R) (Haines *et al.*, 1999). Components of the DQI-R are total fat, saturated fatty acids, dietary cholesterol, fruit intake, vegetable intake, grains, calcium, iron, dietary diversity, and diet moderation. Newby and colleagues (2003) showed, that the DQI-R, which was developed for the use with 24-h recalls, can also be used to measure diet quality using a Food Frequency Questionnaire.

The components of the Healthy Eating Index (HEI) are consumption of grains, vegetables, fruits, milk, and meat. Furthermore, intake of total fat, saturated fat, cholesterol, and sodium, and variety are part of the index (Kennedy *et al.*, 1995). Included components are similar to the ones used in the DQI-R, which is not surprising as they are essentially based on the same dietary recommendations.

McCullough and colleagues (2000a) found that the HEI assessed by a food frequency questionnaire was not associated with a reduced risk of overall major chronic disease in women, although a small reduction of CVD risk was shown, but not for cancer (McCullough *et al.*, 2000b). In men, only a weak association between major chronic disease and HEI was shown. Based on those findings, the Alternate Healthy Eating Index (AHEI) was developed in order to achieve a more specific guidance. The AHEI is composed of 9 variables: vegetables, fruit, nuts and soy, ratio of white to red meat, cereal fibres, trans fat, ratio of polyunsaturated and saturated fatty acids, duration of multivitamin use, and alcohol (McCullough *et al.*, 2002).

Table 1 Selected diet quality indexes

Index	Reference	Components
Mean Adequacy Ratio (MAR)	(Madden & Yoder, 1971)	Energy, protein, calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin, and vitamin C;
Deficient index and Excess index	(Thiele *et al.*, 2004)	Deficient index: vitamin A, D, E, K, B1, B2, niacin, B6, folate, panthotenic acid, biotin, vitamin B12, C, sodium, chloride, potassium, calcium, phosphorus, magnesium, iron, fluoride, zinc, copper, manganese, proteins, carbohydrates, linoleic and linolenic acid, dietary fibres; Excess index: fat, cholesterol, ratio of saturated to unsaturated fatty acids, sugar, alcohol, sodium;
Food Frequency Index (FFI)	(Freisling *et al.*, 2009)	Pasta or rice, wholemeal bread, vegetables (fresh or as a side dish), fruit (fresh) pulses, almonds, peanuts or nuts, milk products, beef or pork, poultry, processed meats;
Diet Quality Index (DQI)	(Patterson *et al.*, 1994)	Total fat, saturated fat, cholesterol, protein, sodium, and calcium, vegetable and fruit consumption, and intake of starches and other complex carbohydrates;
Diet Quality Index revised (DQI-R)	(Haines *et al.*, 1999)	Total fat, saturated fatty acids, dietary cholesterol, fruit intake, vegetable intake, grains, calcium, iron, dietary diversity, and diet moderation;
Healthy Eating Index (HEI)	(Kennedy *et al.*, 1995)	Grains, vegetables, fruits, milk, and meat, total fat, saturated fat, cholesterol, and sodium, and variety;
Alternate Healthy Eating Index (AHEI)	(McCullough *et al.*, 2000a)	Vegetables, fruit, nuts and soy, ratio of white to red meat, cereal fibres, trans fat, ratio of polyunsaturated and saturated fatty acids, duration of multivitamin use, and alcohol;
Diet Quality Scores for Children		
Variety Index for Toddlers (VIT)	(Cox *et al.*, 1997)	Bread, vegetable, fruit, dairy, and meat;
E-KINDEX	(Lazarou *et al.*, 2009)	Bread, cereals and grain foods (excluding bread), fruit and fruit juices, vegetables, legumes, milk, fish and seafood, meat, salted and smoked meat food, sweets and snack items, soft drinks, fried food, grilled food;

2.2 Dietary variety

Several studies have shown that dietary variety is associated with positive health outcomes. This fact can be explained through different possible mechanisms. A limited food choice may lead to low intake of nutrients like iron, calcium, vitamin C, vitamin A, or their precursors because they are concentrated in few foods (Coulston, 1999; World Health Organization Regional Office for Europe, 2000). This might also be true for phytochemicals. Synergistic effects of phytochemicals from different fruits and vegetables also seem to play a role (Liu, 2004). Therefore a wide variety of all foods should be consumed in order to ingest all protective substances (World Health Organization Regional Office for Europe, 2000). Additionally, a combination of a variety of foods lowers the probability of consuming high amounts of toxic substances concentrated in single foods or food groups (Savige *et al.*, 1997).

2.2.1 Definitions

Dietary Variety is inconsistently defined by different researchers and organisations. Also different terms are used [KANT, 1996] to describe the same variety and identical terms are used meaning different varieties. Differences are due to considered reference periods, different food classification systems, and different or not mentioned minimum amounts used which make comparison of data between studies difficult.

Different definitions might also depend on different software used for assessing food consumption and FCDB that allow calculating variety at different levels. Furthermore, differences might occur because of assigning foods to food groups either at ingredient or at recipe level.

Dietary Variety can be considered at different levels. The between-group variety describes from how many different food groups food was selected, within-group variety is the variety within one food group, and the total dietary variety gives the number of how many different foods (of every food group) were consumed. The total dietary variety can be considered as the sum of the within-group varieties of all food groups.

2.2.1.1 Minimum amounts used to assess dietary variety

Some researchers used minimum amounts for foods or food groups that had to be consumed during a certain time period to account for dietary variety. Drewnowski and colleagues, for example, used 30 g as the minimum amount for liquid milk products (e.g. milk, yoghurt), meat, fruit, and vegetables, and 15 g for solid milk products (cheese) and the grain group. (Kant *et al.*, 1991; Kant *et al.*, 1995; (Drewnowski *et al.*, 1996). Kennedy and colleagues (1995) used half a serving of the respective food group as the minimum amount during a 24-hour period. Murphy and colleagues (2006) did not use any minimum amount for their food code-based variety. The Food and Agriculture Organization of the United Nations (FAO) recommend the use of the minimum amounts of 5 g for oils and fats and 10 g for all other food groups in their guidelines for the validation of dietary diversity in two to six year old children (Kennedy & Nantel, 2006).

Those different approaches may not lead to the same results. Falciglia and colleagues, for example, could not find a significant association between their variety score and energy, whereas Royo-Bordonada and colleagues (2003), Foote and colleagues (2004), and McCrory and colleagues (1999) did. Because of the following theoretical considerations, it is clear, that the association between dietary variety and energy and nutrient intake is affected by different applied minimum amounts: if high minimum amounts are applied, higher amounts of a single food or food group have to be consumed to account for variety. Thus, individuals with a varied diet but consuming small portion sizes might get lower variety scores than individuals consuming only from fewer food groups but in higher amounts. As a consequence, applying higher minimum amounts might result in stronger associations between dietary variety and energy and nutrient intake than applying smaller minimum amounts. It has already been shown, that different minimum amounts applied may impact the association between dietary variety and energy intake considerably: when a minimum amount of 0.1 gram was applied, energy intake increased from the category of low to high variety by 22%; when applying a minimum amount of 100 gram, it increased by 56% (Nowak & Elmadfa, 2009).

2.2.1.2 Reference period for assessment of dietary variety

Dietary variety increases when measured over a longer time period, e.g. variety counted over two days is higher than over one day. Drewnowski and colleagues (1997) could, for example, show that the mean Dietary Variety Score (DVS) of young men for one day was 13, for three days 26, and for 15 days 64. Thus, comparison of variety scores is limited when different time periods were used. Falciglia and colleagues found that variety in children increased up to a time period of 14 days (Falciglia *et al.*, 2004).

In a recent study, Falciglia (2009) and colleagues developed and validated equations to predict variety over 15 days from three days food records. They concluded that this method is accurate in estimating food variety and might also be applied to similar populations if validated.

2.2.2 Dietary variety as part of dietary guidelines

In the course of a project of the World Health Organization (WHO) Regional Office for Europe, the countrywide integrated noncommunicable disease intervention (CINDI) programme, the "twelve steps to healthy eating" were developed. Step 1 is "eat a nutritious diet based on a variety of foods originating mainly from plant, rather than animals". This is emphasised again in step 3 that focuses on a variety of vegetables and fruits (WHO Regional Office for Europe, 2000).

According to a report on FBDG from the World Health Organization (WHO) Regional Office for Europe in the WHO European region, most countries have included the recommendation of a varied diet (WHO Regional Office for Europe, 2003).

The first bullet point of the Healthy Eating Guidelines for Austrians is the recommendation to "enjoy a variety of foods" (Elmadfa *et al.*, 2003), without giving further explanations on the term variety.

The German Nutrition Society also recommends to "versatile eating habits", which is further explained in terms of how this should be realised (DGE, 2005). Expressions like "appropriate combination" and "adequate quantities" require the consumers to already have a basic knowledge of nutrition to be able to tell whether a combination is appropriate or not or quantities are adequate or not.

The Dietary Guidelines for Americans included the dietary guideline statement "eat a variety of foods" from the 1st to the 4th edition, but the statement was changed in the 5th edition to "let the pyramid guide your food choice". Reasons for this change were missing evidence for positive effects on nutrient adequacy for within-group variety, the risk of overconsumption through a varied diet, and that consumers did not clearly understand the variety guideline (USDA, 2000; Dixon *et al.*, 2001). In the latest edition of the Dietary Guidelines for Americans, one of the key recommendations is again to choose a variety of foods and beverages within and among the basic food groups, but this recommendation is now given in the context of nutrient-dense foods and beverages and limitation of saturated and trans fats, cholesterol, added sugars, salt, and alcohol (USDA, 2005).

It is also recommended to consume a variety of fruits and vegetables. The guideline gets even more specific for vegetables: vegetables from 5 subgroups should be consumed. Those are dark green, orange, legumes, starchy vegetables, and other vegetables (USDA, 2005).

Australia's "Healthy Eating Pyramid" is accompanied by the sentence "optimal health through food variety and physical activity" (Nutrition Australia, 2010b). Additionally, on their website, more detailed information on variety of foods is provided. Examples on how to enrich ones food variety are given as well as a food variety checklist (Nutrition Australia, 2010a), which was originally published by Savige and colleagues (Savige *et al.*, 1997).

2.2.3 Dietary variety and associations with nutrient intake and nutritional status

One of the first studies dealing with dietary variety was performed by Randall and colleagues (Randall *et al.*, 1985). Different food codes were counted to determine variety. Associations of dietary variety with energy and 7 nutrients (fat, saturated fat, cholesterol, sodium, potassium, calcium, and vitamin A) were evaluated. The authors concluded that, for some nutrients dietary variety can increase dietary adequacy.

Krebs-Smith and colleagues (Krebs-Smith *et al.*, 1987) developed four measures of dietary variety: overall dietary variety (counting of different food items reported in 3 days), variety among major food groups (number of different food groups), variety counting separate foods within major food groups, and variety counting consumed minor food groups within major food groups. MAR increased with variety among five food groups, as well as within those food groups.

Variety is one of the components used to calculate the HEI (Kennedy *et al.*, 1995). The HEI approach to assess variety is commonly used. Variety was defined as the total number of foods that contribute to a food group in an amount of at least half a serving. The same foods eaten at different eating occasions are summed up before they are compared to the half a serving cut-off. Similar foods such as two different forms of potatoes are counted only once.

The Dietary Variety Score (DVS) was defined as the number of different foods consumed over 3 days (Drewnowski *et al.*, 1997). Higher DVS scores were associated positively with vitamin C and negatively with salt, sugar, and saturated fat intake, but they were not associated with DQI. The Dietary Diversity Score (DDS) was defined as the number of food groups consumed, with a maximum of 5 food groups (dairy, meat, grain, fruit, and vegetables). The DDS was associated with lower energy intake (Drewnowski *et al.*, 1996).

Murphy and colleagues compared four different measures of dietary variety: 1. variety score based on food commodities, 2. variety based on the 5 major food guide pyramid groups (grains, vegetables, fruit, dairy, and meat/protein), 3. variety based on the 22 food guide pyramid subgroups, 4. food code-based variety. The variety scores based on food commodities (commodity variety) and on the 22 subgroups of the food guide pyramid showed the strongest associations with nutrient adequacy (Murphy *et al.*, 2006).

Foote and colleagues (2004) assessed the association between the mean probability of adequacy, and food variety in adults, using the HEI approach. Energy intake was highly associated with adequacy. Total dietary variety correlated better with nutrient adequacy than any of the within food group varieties. Dairy and grain contributed the most to the mean probability of nutrient adequacy, vegetables and meat variety the least. Dairy variety was strongly associated with higher calcium and vitamin A adequacy. Variety within the grain group was associated with better folate and magnesium adequacy. Variety within fruits lead to higher probability of adequacy for vitamins C, and A; for vegetables the same results as for fruits could be found, but associations were weaker.

Thiele and colleagues (2004) found that food variety was positively associated with nutrient adequacy (deficient index).

Drescher and colleagues (2007) developed an index to measure healthy food diversity (HFD-Index). This index weights diversity according to the foods' health values. The health values were assigned to the foods depending on their position on the 3-dimensional food pyramid of the German Nutrition Society. Except for vitamin B12, all nutrients at risk of deficient supply showed correlations with the HFD-Index. Higher HFD was also associated with lower sugar consumption and a lower ratio of saturated to unsaturated fatty acids.

A method for measuring dietary variety taking into account the content of macronutrients was developed by Lyles and colleagues (Lyles *et al.*, 2006). A score of 1 was given for foods containing ≥ 5 g carbohydrates and ≥ 20 kcal, ≥ 5 g fat, or ≥ 7 g protein. If for one food or mixed dish more than one of these criteria applied, a score of 1 was assigned for each macronutrient. For whole milk, for example, the score was 1 for carbohydrates, 1 for fat, and 1 for protein. This variety score showed significant associations with Body Mass Index (BMI).

Bernstein and colleagues (Bernstein *et al.*, 2002) assessed the association between two measures of dietary variety with nutritional status in frail elderly people. On the one hand, dietary variety was assessed as the number of different foods during a three day period, on the other hand the number of different fruits and vegetables consumed. A diverse diet regarding both variety measures was associated with a number of indicators. In men, for example, higher diversity scores were associated with higher high-density lipoprotein, lower very-low-density lipoprotein, and triglycerol; in women, an association with blood folate was found.

Dietary variety and its association with nutrient intake and nutritional status in children

The Food and Agriculture Organization of the United Nations (FAO) published guidelines for validation of dietary diversity in children 2-6 years as a measure of dietary nutrient adequacy. Foods are recoded into 10 food groups and, subsequently, 2 DDS are calculated: the first is based on the sum of all consumed food groups, the second one is based on food groups that are consumed in an amount of 10 g or more, except for the group of oils and fats, for which a minimum amount of 5 g is considered (Kennedy & Nantel, 2006).

Royo-Bordonada and colleagues (2003) assessed the association between dietary variety and biochemical status in children (6-7 years). Dietary variety was defined as the number of foods eaten more often than once a month assessed with a Food Frequency Questionnaire (FFQ). Dietary variety was positively associated with plasma levels of alpha- and beta-carotene, lycopene, retinol, alpha-tocopherol, vitamin E, and energy intake.

Falciglia and colleagues (2004) calculated 2 scores in children; one based on the 5 Food Guide Pyramid groups, the other on the food groups grain, fruit, and vegetables, as they are highlighted in the Dietary Guidelines for Americans. Computing was based on the calculation of the variety component of the HEI. Dietary variety was associated with higher intakes of vitamin C and dietary fibres.

Steyn and colleagues assessed whether food variety is a good indicator of nutrient adequacy in children (Steyn *et al.*, 2006). Therefore, a DDS based on 9 food groups (cereals, roots and tubers, vitamin-A-rich fruits and vegetables, other fruit, other vegetables, legumes and nuts, meat, poultry and fish, fats and oils, dairy, eggs) was calculated and a food variety score (FVS) which was defined as the number of foods consumed during 24 hours. DDS and FVS were positively associated with MAR. Furthermore, associations with height-for-age and weight-for-age Z-scores were analysed; both showed positive associations.

A study in children in Mali assessed the association of a Food Variety Score (FVS) and a Dietary Diversity Score (DDS) with MAR. FVS was defined as the number of different food items, DDS as the number of food groups (staples, vegetables, milk, meat, fish, egg, fruits, green leaves) consumed. MAR was positively associated with both variety scores. Thus, the authors concluded that the variety scores can provide a fairly good picture of nutritional adequacy (Hatloy *et al.*, 1998).

Arimond and Ruel (2004) assessed dietary diversity in children from 11 countries. Foods and food groups were recoded into 7 broad food groups: 1. starchy staples, 2. legumes, 3. dairy, 4. meat, poultry, fish, or eggs, 5. vitamin A-rich fruits and vegetables, 6. other fruits and vegetables (or fruit juices), 7. foods made with oil, fat, or butter. Foods that were consumed on at least 3 days during the preceding week got a score of 1, all other foods a score of 0. In 9 of 11 countries, height-for-age Z-scores were associated with dietary diversity (bivariate associations). Authors suggested that, regardless of socio-economic status, child nutritional status is associated with dietary diversity.

In conclusion, a diverse diet is associated with nutrient intake and diet quality. Therefore, informing the public about the importance of a varied diet could be addressed in public health strategies (Thiele *et al.*, 2004).

2.2.4 Energy intake, body weight and dietary variety

Many studies, regardless how dietary variety was defined, showed that variety is positively associated with energy intake. This association was seen in developing countries (Marshall *et al.*, 2001) as well as in industrialised countries (McCrory *et al.*, 1999; Royo-Bordonada *et al.*, 2003; Foote *et al.*, 2004). As overweight and obesity are an increasing health problem, this association is of special interest. However, a few studies did not find a significant association (Falciglia *et al.*, 2004), and others found negative associations (Drewnowski *et al.*, 1996).

McCrory and colleagues proved a significantly positive association of within-group variety regarding 8 food groups with energy intake from foods of the respective food group. Furthermore, variety within the combined food group of breakfast foods, lunch and dinner entrées, sweets, snacks, carbohydrates, and condiments were positively associated with body fatness, whereas variety within the vegetable group showed a negative association. The supply of an increasing variety of food may, thus, be a reason for the increasing obesity prevalence (McCrory *et al.*, 1999).

In a sample of elderly people, positive associations of dietary variety and BMI could be shown in women (Bernstein *et al.*, 2002). Lyles and colleagues (2006) also found associations between their DVS based on food macronutrient content and BMI.

Therefore, when promoting a varied diet, the importance of keeping within an adequate range of energy intake has to be stressed (Foote *et al.*, 2004). A varied diet within the recommended energy intake could be achieved in terms of a healthy food variety as proposed by Drescher et al. (2007), Royo-Bordonada (2003), or Michels and Wolk (2002).

2.2.5 Dietary variety and risk of non communicable diseases

Kant and colleagues showed, that dietary variety was negatively associated with mortality (Kant et al., 1993). Of three mortality causes (cardiovascular disease [CVD], cancer, other [non-CVD, non-cancer] causes), in men all of them were negatively associated with DDS, whereas in women this was the case for CVD and other causes only (Kant et al., 1995).

Some studies showed associations with cancer risk; colorectal cancer (Fernandez *et al.*, 1996), laryngeal cancer (Garavello *et al.*, 2009), esophageal cancer (no significant association was found for meat and cereal diversity) (Lucenteforte *et al.*, 2008), and breast cancer (vegetable variety only) (Franceschi *et al.*, 1995).

No relation was found for total dietary variety with colon cancer; diversity of meats, poultry, fish, eggs, and refined grains increased the risk in men, whereas in women diverse vegetable consumption might have been the cause for a lower colon cancer risk (Slattery *et al.*, 1997).

In a study by La Vecchia and colleagues, variety of vegetables and fruits was negatively associated with stomach cancer, whereas carbohydrate variety was positively associated. The protective effect of total dietary variety regarding stomach cancer was stronger for women than for men (La Vecchia *et al.*, 1997).

Regarding the cardiovascular system, a decrease of the risk of macrovascular disease (Wahlqvist *et al.*, 1989) and hypertension (Miller *et al.*, 1992) were reported.

The Recommended Food Score (RFS) was developed to assess the association of mortality with a diet quality index. It is defined as the number of foods recommended by dietary guideline, namely fruits, vegetables, whole grains, low-fat dairy products, and lean meats and poultry. From a 62-item questionnaire, 23 items were identified as a recommended food. The sum of consumed items out of the 23 recommended foods was the measure used for evaluation of the association of mortality with diet quality (Kant *et al.*, 2000).

Michels and Wolk (2002) investigated the influence of RFS, similar to Kant and colleagues (2000) on mortality in women. Higher RFS showed a significantly lower mortality. Furthermore, they assessed the Non Recommended Food Score (NRFS) which included the rest of the foods. Comparing the influence of the RFS on mortality with the impact of NRFS on mortality, the authors concluded that increasing the number of healthy foods seems to be more important than decreasing the number of unhealthy foods.

2.3 Fruit and vegetable variety

A wide variety of fruits and vegetables is commonly recommended (Krebs-Smith & Kantor, 2001; Australian Government *et al.*, 2005; USDA, 2005).

A fact that underlines a possible additional effect of a variety of fruits and vegetables beyond the quantity of fruits and vegetable consumption is that studies have shown not only an association between cancer and fruit and vegetables, but also between different cancer types and particular groups of fruit and vegetables. For bladder cancer risk, for example, a not statistically significant association was observed with total fruits and vegetables; intake of cruciferous vegetables, broccoli, and cabbage was significantly associated (Michaud *et al.*, 1999). All vegetables, dark-yellow vegetables, tomatoes, citrus fruits and juices were associated with lower risk of esophageal adenocarcinoma (Chen *et al.*, 2002). A study on lung cancer and carotenoids came to the conclusion that a diversity of carotenoid-rich foods might be inversely associated with lung cancer (Michaud *et al.*, 2000).

Vegetable variety was associated with lower risk of breast cancer (Franceschi *et al.*, 1995). Jansen and colleagues examined whether the amount of fruit and vegetable consumption or the variety was associated with cancer risk (Jansen *et al.*, 2004). It was shown that a diet varied in fruits and vegetables has an additional beneficial effect to the amount of fruits and vegetables (Franceschi *et al.*, 1995; Jansen *et al.*, 2004).

Fruit and vegetable variety were associated with laryngeal cancer (Garavello *et al.*, 2009). Women with the highest vegetable variety had a lower risk of colon cancer (Slattery *et al.*, 1997).

Fruit and vegetable variety is associated with nutrient adequacy. Bernstein and colleagues showed that fruit and vegetable variety was significantly associated with higher intakes of several nutrients in elderly, e.g. vitamin C, vitamin A, and potassium (Bernstein *et al.*, 2002). In adults, fruit variety was associated with higher intakes of vitamins C and A; those associations were weaker for vegetable variety (Foote *et al.*, 2004).

In a study on the association between fruit and vegetable variety and nutrient intake in Austrian school children, it was found that fruit and vegetable variety was significantly associated with nutrient densities of vitamin C, folate, vitamin A, beta-carotene, potassium, and dietary fibres (Nowak, 2006).

McCrory and colleagues assessed within-group varieties for 10 food groups. Energy intake increased with within-group variety of each food group; however, a higher vegetable variety was inversely associated with body fatness (McCrory *et al.*, 1999).

Table 2 Selected food variety scores, index components, assessment period, and used minimum amounts per component

Index	Reference	Components	Assessment Period	Minimum amounts
Diet Diversity	(Randall *et al.*, 1985)	Different foods (food codes)	24 hours	n.a.
Food Group Score, Dietary Diversity Score (DDS)	(Kant *et al.*, 1991), (Kant *et al.*, 1995)	Dairy, meat, grain, fruit, vegetables	24 hours	For meat, fruit, vegetables: 30 g for solid foods with a single ingredient 60 g for all liquids and mixed dishes. For dairy and grain groups: 15 g for all solids, 30 g for all liquids and mixed dishes.
Variety component of the Healthy Eating Index (HEI)	(Kennedy *et al.*, 1995)	Total number of different foods	3 days	Half a serving
Dietary Diversity Score (DDS)	(Drewnowski *et al.*, 1996)	Dairy, meat, grain, fruit, vegetables		30 g for liquid milk products, meat, fruit, and vegetables, 15 g for solid milk products and grains.
Variety Index for Toddlers (VIT)	(Cox *et al.*, 1997)	Bread, vegetable, fruit, dairy, and meat	3 days	Food group specific minimum amounts, based on the recommended intake.
Dietary Diversity Score (DDS)	(Kennedy & Nantel, 2006)	Cereals, roots, and tubers; vitamin A rich fruits and vegetables; other fruits; other vegetables; legumes, pulse, and nuts; oils and fats; meat, poultry, fish; dairy; eggs; other (sweets, chips, soda, condiments etc.)	24 hours	5 g for oils and fats, 10 g for all other food groups
Dietary Diversity Score (DDS)	(Steyn *et al.*, 2006)	Cereals, roots, tubers; vitamin A rich fruits and vegetables; other fruit; other vegetables; legumes and nuts; meat, poultry, fish; fats and oils; dairy; eggs	24 hours	n.a.
Dietary Variety Score (DVS) based on food macronutrient content	(Lyles *et al.*, 2006)	Number of food items containing at least ≥ 5 g carbohydrate and ≥ 20 calories, ≥ 5 g fat and/or ≥ 7 g protein	4 days	Food items containing at least ≥ 5 g carbohydrate and ≥ 20 calories, ≥ 5 g fat and/or ≥ 7 g protein
Healthy Food Diversity (HFD-Index)	(Drescher *et al.*, 2007)	15 food groups derived from the 3-dimensional food pyramid of the German Nutrition Society; to each food group, a health factor was assigned; (plant foods; vegetables, fruits, leaf salads, juices; wholemeal products, paddy; potatoes; white-meal products, peeled rice; snacks and sweets; animal foods; fish, low-fat meat, low-fat meat products; low-fat milk, low-fat dairy products; milk, dairy products; meat products, sausages, eggs; bacon; fats and oils; oilseed rape, walnut oil; wheat germ oil, soybean oil; corn oil, sunflower oil; margarine, butter; lard, vegetable fat;	4 weeks, dietary history	n.a.

n.a. not available

2.4 Food neophobia affects children´s dietary variety

Food neophobia can be explained as the aptitude to avoid new foods. Children classified as neophobic show a less varied diet than children not classified as such (Falciglia *et al.*, 2000; Skinner *et al.*, 2002). Neophobia decreases with age (Pelchat & Pliner, 1995). According to Mennella and colleagues, the willingness of children to eat fruit and vegetables may be increased by repeated offers to try a certain or a variety of foods (Mennella *et al.*, 2008).

Nicklaus (2009) suggested that the key to achieving dietary variety is to provide children with a variety of foods. Emphasis should be put on healthy foods. Vegetables are of special importance because it is difficult to promote them later in life.

2.5 Food Based Dietary Guidelines (FBDG) for children

In 2003, the Institute of Nutritional Sciences of the University of Vienna published the Healthy Eating Guidelines for Austrians. They give advice for the general population. (Elmadfa *et al.*, 2003). Recently, the Austrian Food Pyramid (*die österreichische Ernährungspyramide*) has been developed. It offers recommendations for seven food groups (non-alcoholic beverages; vegetables, pulses, and fruits; grain and potatoes; milk and milk products; fish, meat, sausages, and eggs; fats and oils; sweet, savoury, and snacks rich in fat) (Figure 1). In addition to the graphic illustration, recommended intake amounts are specified in household measures as well as in gramms per day (Bundesministerium für Gesundheit, 2010). However, those recommendations are not specific for children.

Figure 1 Austrian Food Pyramid *(die österreichische Ernährungspyramide)* (Bundesministerium für Gesundheit, 2010)

In German speaking countries, the FBDG for children and adolescents guidelines of the “Forschungsinstitut für Kinderernährung in Dortmund” (FKE), called optimiX (optimised mixed diet), are commonly used. Following the optimiX-recommendations, a child shauld be provided with nutrients according to the recent nutrient-based guidelines (D-A-CH, 2000). The guidelines were developed on the basis of common menus for 7 days, which then were optimised (Alexy *et al.*, 2008).

Table 3 shows the optimiX recommendations. Age-appropriate food consumption amounts are given for 11 food groups for 3 age groups, for boys and girls. Food groups are classified into recommended foods, which are further distinguished as “plenty” and “moderate”, and foods which should be consumed rarely and tolerated foods. The group of tolerated foods consists of low nutrient density foods such as sweets, snacks, and sugar added beverages.

Table 3 Age-appropriate food consumption amounts in the optimized mixed diet; modified from (Alexy *et al.*, 2008)

Age (years)		7-9	10-12	13-14 girls/boys	% of total food[1]
Total energy	kcal/d	1800	2150	2200/2700	
	MJ/d				
Recommended foods and beverages ≥90% of total energy					
Plenty:					
Beverages	ml/d	900	1000	1200/1300	38.5
Vegetables	g/d	220	250	260/300	10.0
Fruit	g/d	220	250	260/300	10.0
Potatoes[2]	g/d	220	270	270/330	11.2
Bread, cereals (flakes)	g/d	200	250	250/300	8.1
					∑ 77.8
Moderate:					
Milk, -products[3]	ml (g)/d	400	420	425/450	13.7
Meat, sausages	g/d	50	60	65/75	1.9
Eggs	Pieces/week	2	2-3	2-3/2-3	0.8
Fish	g/week	75	90	100/100	0.4
					∑ 16.8
Rarely:					
Oil, margarine, butter	g/d	30	35	35/40	1.2
Tolerated foods and beverages[4] ≤ 10% of total energy					
	max. kcal/d	180	220	220/270	3.5
	MJ/d	0.75	0.92	0.92/1.13	3.5
					∑ 4.7

[1]Rest: 0.7% (condiments, e.g. vinegar, garlic, mustard, sauce powder)
[2]or noodles, rice and other cereals
[3]100 ml milk correspond ca. 15 g (semi-)hard cheese or 30 g soft cheese
[4]each 100 kcal = 1 scoop of ice cream or 45 g fruitcake or 4 butter cookies or 4 table-spoons sugar or 2 table-spoons jam or 30 g fruit gum or 20 g chocolate or 10 pieces potato chips or 1 glass (200 ml) lemonade, juice drink or fruit nectar

2.6 Monitoring of energy and nutrient intake in Austria

In Austria, nutrition monitoring in children started in 1991. First data were published in the first Nutrition Report of Vienna (*Erster Wiener Ernährungsbericht*) (Elmadfa *et al.*, 1994). In 1998, the first Austrian Nutrition Report was published to describe the nutrition situation in the Austrian population (Elmadfa *et al.*, 1998). This report was then followed by the second edition in 2003 (Elmadfa *et al.*, 2003) and finally the latest edition, the Austrian Nutrition Report 2008 (Elmadfa *et al.*, 2009a).

Over the years, different assessment methods have been used. In the first Austrian Nutrition Report, energy and nutrient intake was assessed through 7-d-food records. Furthermore, nutritional status was assessed through analyses of biochemical markers. Energy and nutrient intake and food consumption data published in the Austrian Nutrition Report 2003 were assessed again through 7-d-food records, but no biochemical analyses were performed.

The most recent study on energy and nutrient intake as well as food consumption in the Austrian population was published in the Austrian Nutrition Report 2008 (Elmadfa *et al.*, 2009a). In children and elderly people, the studies were conducted using 3-d-food records; in adolescents, apprentices, adults, and pregnant women 24-h-recalls were used for data collection. Data were based on food consumption at the individual level and compared to the D-A-CH-Reference Values for Nutrient Intake (D-A-CH, 2000).

For the whole population it was found that energy intake was lower than expected, which was explained through lower physical activity than the reference values were based on. Fat intake was high except for children that ranged at the upper level (35 %E) of the reference values for children, and also the fat quality was not desirable; saturated fat intake, e.g., was high in all population groups (14-19 %E). Protein intake was sufficient, whereas there was a lack of carbohydrate and dietary fibres consumption in most population groups. In children, carbohydrate intake was within the reference of 50%E; however, 17%E were consumed as sucrose. To a great extent, macronutrient intake did not change compared to the report from 2003.

Micronutrient intake is summarised in Table 4 that shows proposed categories of macronutrient intake in the Austrian population for the years 2003 and 2008. Data were based on food consumption at individual level and compared to the D-A-CH-Reference Values for Nutrient Intake (D-A-CH, 2000).

Table 4 Proposed categories of nutrient intake in the Austrian population (assessed on the basis of the D-A-CH-Reference values for Nutrient Intake (D-A-CH, 2000)), modified from (Elmadfa, 2003) and (Elmadfa *et al.*, 2009a)

	Austrian Nutrition Report 2003	Austrian Nutrition Report 2008**
Category 1 (critical)	Total population: dietary folate, iodine, calcium, vitamin D; excess intake of sodium (salt); Elderly (suffering from atrophic gastritis): vitamin B12; Women of childbearing age: iron; Lactating women: vitamin A, vitamin B_6;	Total population: dietary folate, vitamin D, calcium; excess intake of sodium (through salt), Iodine; 6-15 y: iodine 13-15 y: vitamin A, vitamin B_1, B_2, and B_6, iron, and potassium (girls); Women of childbearing age: iron; Pregnant women: vitamin B_6, iodine; Women 75-84 y: vitamin B_1; Men 55-84 y: vitamin A, magnesium;
Category 2 (marginal)	Elderly: vitamin C, E, B_1, B_2 (female), magnesium and zinc (male); Pregnant women: vitamin E and magnesium; Apprentices (15-18 y): vitamin C (male), vitamin B_1, and B_2 and magnesium;	Boys: Zinc Pregnant women: vitamin B_1 and B_2, zinc; 55-84 y: magnesium (women), vitamin B_6 (men);
Category 3 (sufficient)	Niacin, biotin, panthotenic acid, potassium, phosphorus, manganese, copper	Total population: vitamin E, vitamin C, niacin, biotin, panthotenic acid, phosphorus, manganese, copper;
Category 4 (not yet assessed)*	Vitamin K, fluoride, selenium, and carotenoids	Total population: vitamin K, fluoride, selenium

*not yet exactly assessed in the total population
**quartile 1: intake more than 15% below the respective reference value; quartile 2: intake up to 15% below the respective reference value; intake more equal or above intake more than 15% below the respective reference value

3. Materials and Methods

Data used in this dissertation were collected in the "Austrian Study on Nutritional Status in Children 2007" (ÖSES.kid07) which was carried out as part of the project "Austrian Nutrition Report 2008", funded by the Austrian Federal Ministry of Health. The following chapters will introduce the background and scope of ÖSES.kid07. Furthermore, data management and analyses will be described in detail.

The project "Austrian Nutrition Report 2008" (Elmadfa *et al.*, 2009a) was started to follow up on the first two Austrian Nutrition Reports from 1998 (Elmadfa *et al.*, 1998) and 2003 (Elmadfa *et al.*, 2003). As one of the primary aims of the report was to give an overview on the nutrition situation of different population groups different studies were initiated to fulfil this task. ÖSES.kid07 targeted a comprehensive description of the nutrition situation of six to fifteen years old children in Austria.

3.1 Food record

Öses.kid07 included a child questionnaire, a parent questionnaire, and a 3-day food record for the child. All material was constructed taking into account increasing reading and writing competences with age. Therefore, questions, content, length, and layout were adopted for three age groups. The first group included the 1st and 2nd school grade, the second group was developed for the 3rd and 4th grade, and the third age group included the 5th to 8th grade.

Pilot testing was conducted from March to April 2007 with 60 children (25 from 1st - 2nd, 19 from 3rd – 4th, 16 from 5th – 8th grade) and 42 parents (20 from 1st – 2nd, 22 from 3rd – 8th grade). Questionnaires were tested for understanding and reproducibility. Furthermore, the time needed to complete the questionnaire was noted. Subsequently, questions were changed in order to facilitate the task for children and parents and to get valid information.

All questionnaires and records were coded with a 6-digit identification number (2 digits identifying the school and class, 4 digits serial number) to ensure the unambiguously matching of food records, child and parent questionnaire of the individual participants.

The Food Record was conceptualised for three consecutive days. As the level of writing competence of particularly the youngest participating children was expected to be low, parents were asked to help them with keeping the food records.

Children and parents were asked to estimate the portion sizes using either household measures (e.g. tee spoon, glass), or the portion size, of the included picture book.

The picture book included selected pictures of the EPIC-SOFT picture book for determination of portion sizes (Slimani & Valsta, 2002). For better estimation of the amount of beverages selected pictures from the 2nd Bavarian Nutrition Survey were used (Himmerich *et al.*, 2004). When necessary, self-made pictures were added. For each item, pictures of a small, a medium, and a large portion were given (see example Figure 2).

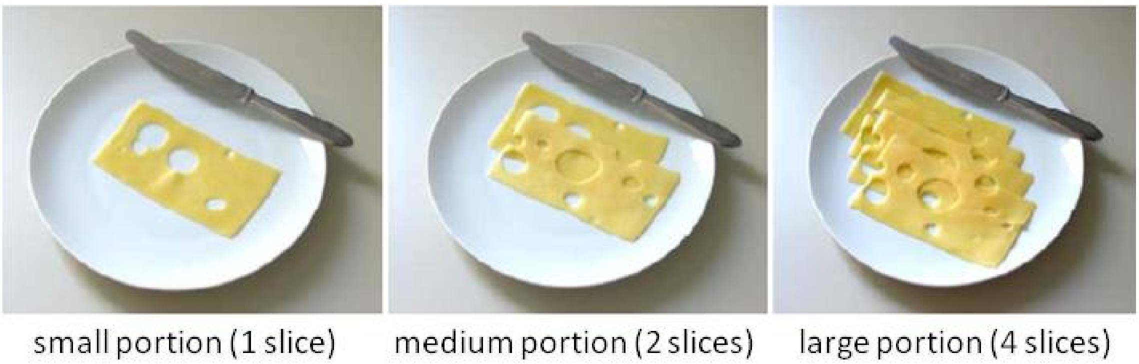

Figure 2 Portion sizes of cheese, example from the picture book

3.2 Measurement of body height and body weight

Body height and body weight of the pupils were measured in the schools. Body weight was measured with the children wearing light clothes using the scale Seca bella 840. For measuring standing body height the mobile stadiometer Seca 214 was used.

3.3 Data collection

Data collection was performed by students of the Institute of Nutritional Sciences, University of Vienna. Those students were trained beforehand in order to harmonise data collection. Training included measurement of body weight and body height and instructions on how to support children in completing the questionnaire and how to explain the food record and picture book. Furthermore, data collection followed a protocol which was guided by a checklist.

Data were collected from June 2007 to June 2008. The collection was done in the classrooms of the participating classes.

The explanations about the study were adapted to the children´s age. Each child received an envelope with the child and the parent questionnaire as well as the food record. Following the protocol, supported by a checklist, children were given oral instructions on how to fill in the questionnaires.

For the 1st and 2nd form, overhead-transparencies were used in order to facilitate the children's understanding of the questions and to guide them through the questionnaire.

After completing the questionnaire, the children were instructed how the 3-day food record works. The picture book used was explained in depth and a poster was put on a wall inside the classroom to remind them of filling in the food record and of using the portion sizes. Younger children were asked to go to their parents when having difficulties and to ask them for help. The next step was the measurement of body weight and body height.

Children took the parents' questionnaires home and handed them over to their parents. Either the mother or the father filled in the information. At least four days after the data collection, children had to return the envelope with the parent questionnaire and the food record so that their teacher could send a pre-addressed and pre-paid box with all the questionnaires back to the Institute of Nutritional Sciences, University of Vienna.

3.4 Sampling

The target population for ÖSES.kid07 was all children from the six to 15 years of age. Children were approached via schools. The targeted grades of school were the 1st to the 8th form.

In adults, a sample size of about 2,000 participants is recommended for nutrient intake evaluation (Volatier *et al.*, 2002). According to this recommendation ÖSES.kid07 aimed to include 2,000 children and their parents in the study.

For the Austrian Nutrition Report 2008 Austria was divided into 4 geographical regions: the eastern region included the provinces of Lower Austria, Upper Austria, and Burgenland; the western region was Vorarlberg, Salzburg, and Tyrol; region South included Styria and Carinthia, and Vienna was considered the fourth region.

Participants were recruited via cluster sampling. Schools were selected randomly from a complete list of Austrian primary, grammar, and secondary schools (Bundesministerium für Unterricht und Kunst, 2007). Schools for special needs were excluded. The necessary number of classes per region was calculated using figures from Statistik Austria (Statistik Austria, 2007). 51 primary classes and 44 classes of grammar and secondary schools were needed.

As soon as the consents of the responsible school boards of the nine Austrian provinces were obtained, schools were informed about the study and asked for participation. In case a school was not interested the next school in the randomly sorted list of schools was contacted. The next step was to send information to the parents including a consent form that had to be signed in case parents agreed to the participation of their child.

The intended sample size of 2,000 schoolchildren was not reached due to several reasons. One of them was the late received consent of school boards in specific Austrian provinces, especially Vienna. Schools refused participation because of lack of time, lack of teachers, lack of interest or willingness, or other priorities.

As the final sample size in Vienna was too small, Vienna was assigned to the eastern region, resulting in three rather than four regions.

3.4.1 Participation

From the 122 contacted schools, 46 schools were interested in participation with 57 classes. Those 57 classes encompassed 1,120 pupils.

For participation, children had to bring a consent form signed by their parents to school, they had to be in school on the day of data collection and they had to be willing to participate themselves. This was the case with 1,006 children. A detailed description on the participation, returned and usable questionnaires and food records is given in Figure 3. All questionnaires that were filled in only partly (less than two thirds of the whole questionnaire) or were filled in obviously incorrect were excluded.

Figure 3 Participation and dropout rate in the ÖSES.kid07 study

3.4.2 Under- and over-reporting

To identify severe under- and over-reporters, the method proposed by Goldberg et al. (Goldberg *et al.*, 1991) was used. Used parameters are summarised in Table 5.

Using a PAL of 1.2 for under-reporting and 1.55 for over-reporting and the 99.7th confidence interval, those parameters result in very liberal cut-offs. Those cut-offs (mis-reporter cut-off 1) were also used for data presented in the Austrian Nutrition Report 2008 (Elmadfa *et al.*, 2009a).

Table 5 Parameters used to assess over-reporting and under-reporting

	Mis-reporter cut-off 1	Mis-reporter cut-off 2
Within-individual coefficient of variance	23%	23%
Coefficient of variance for Basal Metabolic Rate (BMR)	8.5%	8.5%
Coefficient of variance for Physical Activity Level	15%	15%
Number of days	3	3
Number of persons	1	1
Physical Activity Level (under-reporting/over-reporting)	1.2/1.55	1.55/1.55
Confidence interval	99.7%	95%
	Under-reporting: Energy intake<0.62xBMR Over-reporting: Energy intake>2.98xBMR	Under-reporting: Energy intake<1.00xBMR Over-reporting: Energy intake>2.40xBMR

The use of those parameters resulted in the definition of under-reporters as children reporting a daily energy intake of less than 0.62 times the Basal Metabolic Rate (BMR), and over-reporters as children reporting more than 2.98 times the BMR. The Basal Metabolic Rate was estimated from preferably measured data on body weight and body height according to Schofield (Schofield, 1985). Only in cases where no measured data were available were self reported data used for BMR estimation.

As above presented parameters may only identify severe under- and over-reporters, a sensitivity analysis was performed using a more conservative and widely used parameter set (mis-reporter cut-off 2; physical activity level = 1.55, confidence interval = 95%) to assess whether this further exclusion would influence the results.

3.4.3 Data entry and processing

3.4.3.1 Questionnaire data

To ensure unified data entry, questionnaire data were put into SPSS 17 (SPSS Inc.) using codebooks. For minimising possible mistakes, data entry was revised a second time by another person. Whenever problems occurred, such as inconclusive answers, a record was kept. Special designed forms were used to ensure all necessary information was noted.

3.4.3.2 Food record data

Data from food records were entered and processed using an Access 2003 database of the Institute of Nutritional Sciences based on the German Food Composition Database BLS.II.3.1 (Hartmann *et al.*, 2005) which was extended by Austrian products and dishes. Liquids reported in volume units (ml, l) were not converted into grams using density values; 1 ml was interpreted as 1 g. Nutrients consumed through supplements were not considered, whereas nutrients consumed through fortified foods were.

Not all children managed to keep the records for three days. In order not to refuse valuable information, these data, too, were kept for analyses.

3.4.3.3 Food group classification

The “Forschungsinstitut für Kinderernährung in Dortmund” (FKE) developed a FBDG for children and adolescents called optimiX (Table 3) (Alexy *et al.*, 2008). Food groups suggested in these guidelines were used for assessment of diet quality.

Foods were assigned to food groups at ingredient level. OptimiX does not give clear information on nuts and seeds. According to the “Austrian 5 A Day” campaign, a small portion of nuts may replace one fruit portion a day. Following this recommendation, nuts were assigned to the food group fruits (Agrarmarkt Austria Marketing, 2009). As seeds have similar nutrient content, they also were assigned to this food group.

The recommendation for milk and milk products includes cheese as follows: 100 ml milk corresponds to about 15 g (semi-)hard cheese or 30 g soft cheese, taking into account different calcium-densities of milk and cheese. According to this, cheese intake was converted into the corresponding milk amount; the amount of (semi-)hard cheese [g] was multiplied with the factor 6.7, soft cheese with the factor 3.3.

3.5 Classification of body height and weight

In adults, the Body Mass Index (BMI), which is defined as body weight in kg divided by the squared body height (BMI = body weight/body height^2), is used to assess prevalence of underweight, normal weight, overweight and obesity. As the BMI changes with age, BMI cut-offs for adults cannot be used to classify children. Therefore, other methods have been proposed (Cole *et al.*, 2000; Kromeyer-Hauschild *et al.*, 2001; Cole *et al.*, 2007). The present study used the percentiles according to Kromeyer-Hauschild and colleagues (Kromeyer-Hauschild *et al.*, 2001). Overweight and obesity were defined as BMI >90th reference percentile and BMI >97th, respectively; underweight was defined as BMI <10th reference percentile.

3.6 Dietary adequacy

3.6.1 Nutrient adequacy

Two indices of nutrient adequacy, deficient index and excess index, were constructed following the methodology used by Thiele and colleagues (Thiele *et al.*, 2004). Table 6 shows nutrients included for both, the deficient and excess index.

Table 6 Nutrients considered in the deficient and excess indexes

Deficient index	**Vitamins**: Vitamin A (retinol equivalents), Vitamin D, Vitamin E, Thimain, Riboflavin, Niacin (equivalents), Panthotenic acid, Pyridoxin, Biotin, Folate, Cobalamin, Vitamin C **Minerals**: Sodium, Chloride, Potassium, Calcium, Phosphate, Magnesium, Iron, Iodine, Zinc, Copper, Manganese **Macronutrients**: Protein (g/kg body weight/d), Carbohydrates (%E), Linoleic acid (%E), Linolenic acid (%E), Dietary fibres
Excess index	Saturated fatty acids (%E), Cholesterol, Sucrose (%E), Sodium, Fat (%E)

Nutrient adequacy ratios (NAR) were calculated as the ratio of nutrient intake and D-A-CH reference values for nutrient intake (D-A-CH, 2000). For the excess sodium reference value, the recommendation from "Food, Nutrition, PA, and Prevention of Cancer" (World Cancer Research Fund & American Institute for Cancer Research, 2007) was considered, for sucrose the recommendation from the WHO/FAO (WHO & FAO, 2003).

Twenty-eight nutrients were considered in the deficient index. NARs were multiplied by 100. If a person reached more than 100% of the reference value, the value was truncated at 100, resulting in a possible range for each nutrient of 0-100. The values for all 28 nutrients were summed up. The (theoretical) possible range for the deficient index was 0-2800. The higher the value, the better nutrient intakes correspond to the reference values.

The excess index was constructed from five nutrients at risk of excess consumption. For the excess index in a first step also NARs were also calculated. All values below 100% were set at the maximum of 100. Each percentage point above 100% was subtracted from the maximum of 100 points. A minimum was set at 0 (no negative values were possible). So values ranged from 0-100 for every single nutrient. Values were added up resulting in a possible range of 0-500. The higher the excess index, the better the child's nutrient intake complied with the reference values.

3.6.2 Food Group Adequacy (FGA)

An Index for adequate food intake was calculated based on the optimiX recommendations (Table 3) (Alexy *et al.*, 2008). In a first step, Food Adequacy Ratios (FAR) were calculated following the same approach as above described for NARs: intake amounts of foods and beverages were divided by the recommended amounts. In case the recommended amount was given as a range, the mean of the range was taken into account (e.g. food group eggs: 2-3 pieces/week was translated into 2.5 eggs/week).

OptimiX gives recommendations for recommended and tolerated foods. Furthermore, the recommended foods are divided into foods of which plenty should be consumed, foods that should be consumed in moderation, and foods to be eaten rarely. Different truncation strategies were applied to those different food classes:

- Foods, of which plenty should be consumed: FAR were truncated at 100.
- Foods to be consumed in moderation: each percentage point above 100% was subtracted from the maximum of 100. A minimum was set at 0 points.
- Foods to be consumed sparingly and tolerated foods: FARs below 100% were set at the maximum of 100. Each percentage point above 100% was subtracted from the maximum of 100. A minimum was set at 0 points.

In a second step, FARs were summed up, resulting in a theoretical maximum for FGA of 1100.

3.7 Dietary variety

Dietary variety changes over time (Drewnowski *et al.*, 1997; Falciglia *et al.*, 2004), the longer the survey period, the more different foods are consumed. Therefore, only food records covering the same time period can be compared directly. From 39 children, only one or two days of food records could be used. Those records were excluded from dietary variety assessment. Therefore, variety was assessed for 741 children.

3.7.1 Between-Group Variety (BGV)

To determine BGV, foods and beverages were grouped according to the eleven food groups proposed by the optimiX recommendations (Alexy *et al.*, 2008): beverages, vegetables, fruits, potatoes/noodles/rice/other cereals, bread/cereal (flakes), milk/-products, meat/sausages, eggs, fish, oil/margarine/butter, tolerated foods/beverages. Two different BGV indexes were calculated:

- BGV1: Minimum amounts were set at 25% of the recommended amount were applied for all food groups except for the tolerated foods.
- BGV2: This score was calculated considering the minimum amounts proposed by Kennedy and Nantel (Kennedy & Nantel, 2006) who recommended 10 gram per food group and 5 g for fats and oils for 2-6 year old children. Taking into account bigger portion sizes for children aged 6-15 years in the present study,

for BGV2 minimum amounts of 20 g per food group and 10 g for fats and oils were used. Tolerated foods were excluded.

3.7.2 Fruit and Vegetable Variety (FVV)

Fruit and Vegetable Variety (FVV) was defined as all fruits and vegetables listed in the food record. A minimum intake amount for each fruit and vegetable sort of 20 g/d was assigned.

In general, the corresponding food codes from used food composition databases are used to determine within group variety. As the German BLS provides data on foods at different processing stages, this approach would lead to inappropriately high variety scores. Therefore, the same food at different processing stages was recoded into one and the same food variety code. No further point was assigned for apple juice, for example, when an apple had already been eaten by the same child.

Accordingly, Fruit Variety (FV) and Vegetable Variety (VV) were calculated separately.

3.8 Statistical analyses

All statistical analyses were performed using the statistical software package SPSS 17 (SPSS Inc.) or Stata statistical software, version 10.0 (StataCorp, 2008). Differences between means of 2 groups were analysed using t-test; for assessing differences between several means, Oneway ANOVAs were applied. When group variances were different, results of the Welch-test were considered. Post hoc pairwise comparisons were carried out using Tukey’s test when sample sizes and group variances were similar, Gabriel's test when sample sizes were different, and Games-Howell's test when group variances were different (Field, 2009).

χ^2-test was used to identify significant differences of frequencies of observed nominal and ordinal data. Bivariate associations were assessed with Spearman correlation coefficients.

Multiple linear regression models were applied to adjust for potential confounders such as age, BMI, gender, total amount of foods consumed (or foods from observed food groups, respectively) and energy intake. Energy was not used as an independent variable in models where energy was the dependent variable (or part of the dependent variable when the dependent variable was given as %E). Prior to analyses, non-linear distributed numerical variables were properly transformed (natural logarithm). Data then were back-transformed and reported as geometric means. Each model was tested for assumption of linear regression and fit of the model.

Indexes of diet quality and dietary variety were divided into four categories according to the quartiles, where quarter 1 represents “low diet quality/variety” and quarter 4 “high diet quality/variety”. Therefore, scores were introduced into the regression models as dummy variables. The variable gender was coded as 0 for male and 1 for female. Age, energy intake [MJ], and BMI were introduced into the models as centred at their means. P for trend across categories of the indexes was calculated using a linear contrast ($-\beta_2 + \beta_3 + 3\beta_4 = 0$) (Vittinghoff *et al.*, 2005).

A sensitivity analysis was performed to assess the robustness of the models in respect more conservative cut-off values for under- and over-reporting (see section 3.4.2). The sensitivity analysis was conducted through performing linear regression models of energy and nutrient intake for the respective subgroups. As in the models described above, the variable gender was coded as 0 for male and 1 for female, and age, energy intake [MJ], and BMI were introduced into the models as centred at their means. In contrast to the above models, indexes of diet quality and dietary variety, respectively, were not introduced into the models as categories but as metric variables.

4. Results

4.1 General characteristics of the participants

The mean age was 10.6 years (SD 2.1) with a minimum of 6.6 and a maximum of 15.4 years; the mean age of boys was 10.8 (SD 2.1) and 10.5 (SD 2.1) for girls. Table 7 shows general characteristics of the sample. The age groups were defined on the basis of the age groups of optmiX (Alexy *et al.*, 2008) and the D-A-CH reference values (D-A-CH, 2000). Only three children were six years old, and three children were 15 years old. In order not to exclude informative data, age groups were built as shown in Table 7.

Table 7 Socio-demographic characteristics of the subjects, (n=780)

	Boys n (%)	Girls n (%)
Gender	389 (50)	391 (50)
Age		
6-9 y	148 (38)	175 (45)
10-12 y	155 (40)	152 (39)
13-15 y	86 (22)	64 (16)
Region		
East (incl. Vienna)	142 (37)	154 (39)
South	125 (32)	143 (37)
West	122 (31)	94 (24)

4.1.1 Anthropometric characteristics

Mean BMI in boys was 18.6 kg/m^2 (SD 3.1) and 18.6 kg/m^2 (SD 3.5) in girls. 78.7% of boys and 77.7% of girls were classified as normal weight. A high proportion of 10.5% of boys and 9.5 of girls were overweight and 5.7% of boys and 5.7% of girls were classified as obese. There was no significant association between gender and the prevalence of BMI categories χ^2 (3) = 1.27, p=.736 for the whole sample. Stratified for age groups, a significant association could be shown for the oldest age group only χ^2 (3) = 13.14, p=.004. In this age group, more girls were underweight as well as overweight and obese than boys, resulting in a lower prevalence of normal weight in girls compared to boys.

Table 8 Mean Body Mass Index (BMI) and classification of body weight and body height, n (%) (Kromeyer-Hauschild *et al.*, 2001)

		n	mean BMI	Underweight	Normal weight	Overweight	Obese	p-value[1]
			kg/m^2	n (%)	n (%)	n (%)	n (%)	
Total	Boys	400	18.6 (3.1)	20 (5.1)	306 (78.7)	41 (10.5)	22 (5.7)	.736
	Girls	380	18.6 (3.5)	27 (6.9)	304 (77.7)	37 (9.5)	23 (5.9)	
6-9 y	Boys	148	17.6 (2.6)	5 (3.4)	109 (73.6)	24 (16.2)	10 (6.8)	.401
	Girls	175	17.2 (2.4)	8 (4.6)	139 (79.4)	18 (10.3)	10 (5.7)	
10-12 y	Boys	155	18.8 (3.2)	9 (5.8)	122 (78.7)	13 (8.4)	11 (7.1)	.610
	Girls	152	18.5 (2.9)	11 (7.2)	124 (81.6)	11 (7.2)	6 (3.9)	
13-15 y	Boys	86	19.4 (2.7)	6 (7.0)	75 (87.2)	4 (4.7)	1 (1.2)	.004
	Girls	64	21.1 (4.3	8 (12.5)	41 (64.1)	8 (12.5)	7 (10.9)	

[1]p-value for differences between boys and girls (chi-square test)

4.2 Dietary adequacy

4.2.1 Deficient and excess index

For describing nutrient adequacy, two indexes were constructed: the deficient (28 nutrients included) and the excess index (5 nutrients included). The mean deficient index was 2317 ± 267.7 (mean ± SD) with a minimum of 1442 and a maximum of 2764. Boys showed a significantly higher deficient index (mean=2338, SE=13) than girls (mean=2297, SE=14), t(778)=2.16, p=.031. There was a significant effect of nutrient adequacy ratio on age, F(2, 375) = 77.65, p<.001 (F adjusted, Welch-test). Younger children showed higher deficient indexes than older children. No effect was found for BMI, F(3, 776)=0.56, p=.645.

The mean excess index was 327 ± 61.2 (mean ± SD) with a minimum of 92 and a maximum of 500. Girls showed a significantly higher excess index (mean=337, SE=3.1) than boys (mean=317, SE=3.0), t(778)=-4.5, p<.001. No significant effect of the excess index on age was found, F(2, 777)=2.95, p=.053. As already for the deficient index, also for the excess index no effect of BMI was seen either, F(3, 776)=0.85, p=.467.

The deficient index and the excess index were significantly related, r_s=-.56, p<.001. This means that children with a high deficient index (a desirable nutrient intake) have a higher probability to have a lower excess intake (an undesirable nutrient intake).

The deficient index is highly associated with energy intake, r_s=.73, p<.001 and the same was true for the excess index, r_s=-.69, p<.001.

Table 9 Deficient and Excess index scores by gender, age and BMI-classes

	Deficient index		Excess index	
	Mean (SE)	Median (IQR)	Mean (SE)	Median (IQR)
Total (n=780)	2317 (10)	2370 (368)	325 (2.3)	320 (76)
Gender				
Boys (n=389)	2338 (13)	2384 (356)	314 (3.1)	312 (77)
Girls (n=391)	2297 (14)	2336 (395)	335 (3.2)	332 (80)
Age				
6-9 y (n=323)	2436 (12)	2491 (256)	319 (3.5)	313 (67)
10-12 y (n=307)	2272 (15)	2325 (366)	329 (3.7)	325 (85)
13-15 y (n=150)	2156 (23)	2151 (403)	329 (5.1)	332 (81)
BMI classes				
Underweight (n=47)	2283 (37)	2303 (437)	334 (9.5)	321 (90)
Normal weight (n=610)	2316 (11)	2369 (371)	325 (2.6)	320 (78)
Overweight (n=78)	2361 (30)	2430 (308)	321 (7.1)	321 (67)
Obese (n=45)	2302 (36)	2324 (338)	314 (8.2)	312 (67)

4.2.2 Food group consumption and Food Group Adequacy (FGA)

Table 10 gives an overview of food group consumption. Most food groups were consumed in smaller amounts than recommended by optimiX. Younger children reached the recommendations to a higher extent than the older age groups did. Six to nine year old boys and girls, for example, consumed only 45% and 44% of the recommendation for vegetable consumption, respectively; in comparison, 13-15 year old boys only consumed 30% and girls only 28% of the recommendation. In contrast to vegetable consumption, girls of all three age groups and the youngest group of boys reached the recommendation for fruit intake, and also the older boys were not far behind (10-12 y: 96%, 13-14y: 84%). Recommendations for the food group meat and sausages were exceeded by all age groups, ranging from 108% in 13-15 year old girls to

166% in 6-9 year old boys. An excess intake was found for the food group of tolerated foods, ranging from 148% of the recommendation in 13-15 year old girls to 213% in 6-9 year old boys. In this food group, the recommendation is given as kilocalories from tolerated foods (low nutrient density foods such as sweets, snacks, and sugar-added beverages), which makes it possible to also account for very diverse energy densities within the tolerated food group.

To describe overall diet quality, the Food Group Adequacy (FGA) was calculated by comparing the intake of food groups with the recommendation. Summary statistics are given in Table 11, the distribution of FGA is shown in Figure 4. The mean FGA was 505 ± 104.6 (mean ± SD) with a minimum of 162 and a maximum of 848 of a theoretical maximum of 1100. FGA scores were not significantly different between boys (mean=500, SE=5.3) and girls (mean=511, SE=5.3), $t(778)=-1.45$, $p=.148$. No effect was found for BMI, $F(3, 776)=2.09$, $p=.100$. In contrast, a significant effect of age on FGA was observed, $F(2, 777)=15.69$, $p<.001$, where younger children showed the highest FGA (6-9 y: mean=529, SE=5.5; 10-12 y: mean=492; SE=6.1, 13-15 y: mean=481, SE=8.1). One reason for lower FGA in older children might be the higher prevalence of under-reporting in older children, which has already been reported several times (Rennie *et al.*, 2005; Lioret *et al.*, 2011).

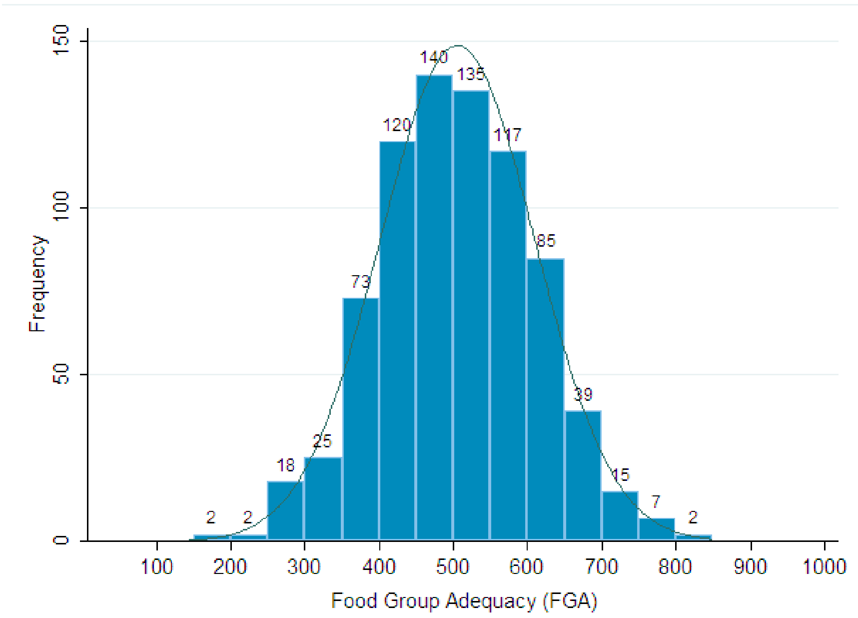

Figure 4 Distribution of Food Group Adequacy (FGA) in Austrian school children (n=780)

Table 10 Daily food consumption of Austrian 6-15 year old school children

	Boys					Girls				
Daily consumption	mean	sd	median	IQR	optimiX	mean	sd	median	IQR	optimiX
6-9 years										
Beverages[3] [g]	710	425	671	576	900	686	356	659	488	900
Vegetables [g]	98	76	71	91	220	97	77	76	87	220
Fruit[2] [g]	240	210	190	225	220	256	209	226	230	220
Fruit juice [g]	113	159	49	167		125	186	62	167	
Potatoes, rice, other cereals [g]	121	55	116	71	220	117	57	107	72	220
Bread, cereal flakes [g]	104	49	99	61	200	96	49	90	66	200
Milk and –products[1] [g]	411	229	391	296	400	341	182	338	255	400
Milk without cheese [g]	295	185	267	244		252	157	226	214	
Soft cheese [g]	6	10	0	11		6	9	0	11	
Hard cheese [g]	14	19	9	21		10	15	3	17	
Meat, sausages [g]	83	43	80	54	50	68	41	63	48	50
Eggs [g]	19	19	12	22	17	19	19	12	21	17
Fish [g]	12	21	0	23	11	9	17	0	15	11
Oil, butter, margarine [g]	20	10	19	12	30	20	10	19	11	30
Tolerated food [g]	269	282	162	280		210	215	142	181	
Energy from tolerated food [MJ]	1.60	0.99	1.41	1.18	0.75	1.44	0.84	1.33	1.16	0.75
10-12 years										
Beverages[3] [g]	687	474	579	613	1000	626	469	563	453	1000
Vegetables [g]	88	67	75	99	250	84	59	74	85	250
Fruit[2] [g]	239	216	184	272	250	276	231	200	268	250
Fruit juice [g]	123	164	50	183		149	204	83	225	
Potatoes, rice, other cereals [g]	110	55	105	75	270	122	73	109	70	270
Bread, cereal flakes [g]	113	54	104	80	250	93	49	87	56	250
Milk and –products[1] [g]	383	211	347	285	420	307	183	275	272	420
Milk without cheese [g]	260	168	231	211		211	148	193	208	
Soft cheese [g]	5	8	0	10		8	12	3	11	
Hard cheese [g]	16	20	11	27		10	14	5	0	
Meat, sausages [g]	92	52	86	65	60	72	45	64	59	60
Eggs [g]	18	21	12	20	17-26	16	19	9	17	17-26
Fish [g]	10	19	0	15	13	9	18	0	13	13
Oil, butter, margarine [g]	19	10	19	14	35	18	9	17	9	35
Tolerated foods [g]	286	285	221	282		274	343	205	213	
Energy from tolerated food [MJ]	1.56	1.09	1.33	1.26	0.92	1.43	1.11	1.25	1.30	0.92

[1]semi-hard and hard cheese: 15 g correspond to 100 ml milk, soft cheese: 30 g correspond to 100 ml milk; adjusted sum; [2]inclusively fruit juice; [3]inclusively water contained in dishes

Table 10 continued Daily food consumption of Austrian 6-15 year old school children

	Boys					Girls				
Daily consumption	mean	sd	median	IQR	optimiX	mean	sd	median	IQR	optimiX
13-15 years										
Beverages[3] [g]	701	549	619	742	1300	636	536	483	541	1200
Vegetables [g]	90	58	73	73	300	74	54	59	84	260
Fruit[2] [g]	251	353	180	261	300	279	216	218	204	260
Fruit juice [g]	152	324	10	222		115	170	20	177	
Potatoes, rice, other cereals [g]	126	71	117	108	330	101	57	86	85	270
Bread, cereal flakes [g]	117	54	112	75	300	98	50	100	62	250
Milk and –products[1] [g]	398	211	398	219	450	271	26	235	218	425
Milk without cheese [g]	280	188	260	202		175	19	133	212	
Soft cheese [g]	8	10	0	13		7	10	0	11	
Hard cheese [g]	14	18	8	20		11	17	6	13	
Meat, sausages [g]	100	67	83	72	75	70	49	65	57	65
Eggs [g]	17	19	11	19	17-26	15	16	12	21	17-26
Fish [g]	9	17	0	19	100	10	22	0	9	100
Oil, butter, margarine [g]	21	10	20	13	40	18	9	16	13	35
Tolerated foods [g]	358	396	222	442		270	231	224	283	
Energy from tolerated food [MJ]	1.65	1.06	1.59	1.64	1.13	1.35	0.88	1.26	1.16	0.92

[1]semi-hard and hard cheese: 15 g correspond to 100 ml milk, soft cheese: 30 g correspond to 100 ml milk; adjusted sum; [2]inclusively fruit juice; [3]inclusively water contained in dishes

Table 11 Mean Food Group Adequacy index (FGA) scores by gender, age, and BMI-classes (n=780)

	FGA	
	Mean (SE)	Median (IQR)
Total (n=780)	465 (3.7)	466 (136)
Gender		
Boys (n=389)	465 (5.3)	457 (137)
Girls (n=391)	474 (5.2)	474 (131)
Age		
6-9 y (n=323)	488 (5.6)	487 (129)
10-12 y (n=307)	464 (5.9)	465 (136)
13-15 y (n=150)	419 (7.9)	417 (135)
BMI classes		
Underweight (n=47)	445 (13.8)	449 (152)
Normal weight (n=610)	467 (4.3)	466 (142)
Overweight (n=78)	475 (10.6)	477 (109)
Obese (n=45)	445 (17.4)	437 (138)

4.2.3 Food Group Adequacy (FGA) and nutrient intake

The optimiX guidelines were developed in order to fulfil nutrient requirements (Alexy *et al.*, 2008). It is, therefore, interesting to see to which extent nutrient adequacy indices correlated with the FGA. There was a significant relationship between FGA and the deficient index, r_s=.42, p<.001, but no association with the excess index, r_s=-.06, p=.07. The correlation with energy was weak, r_s=.16, p=<.001.

In multiple linear regression models, the efficiency of the FGA in describing dietary quality in terms of nutrient adequate nutrient intake was further evaluated. Energy and 33 nutrients were tested in linear regression models. Energy and twenty-eight out of the tested nutrients showed significant changes from quarter 1 to quarter 4 (see Table 12 Table 13). Figure 5 illustrates the decrease of sucrose intake by FGA. Error bars represent the 95% confidence intervals.

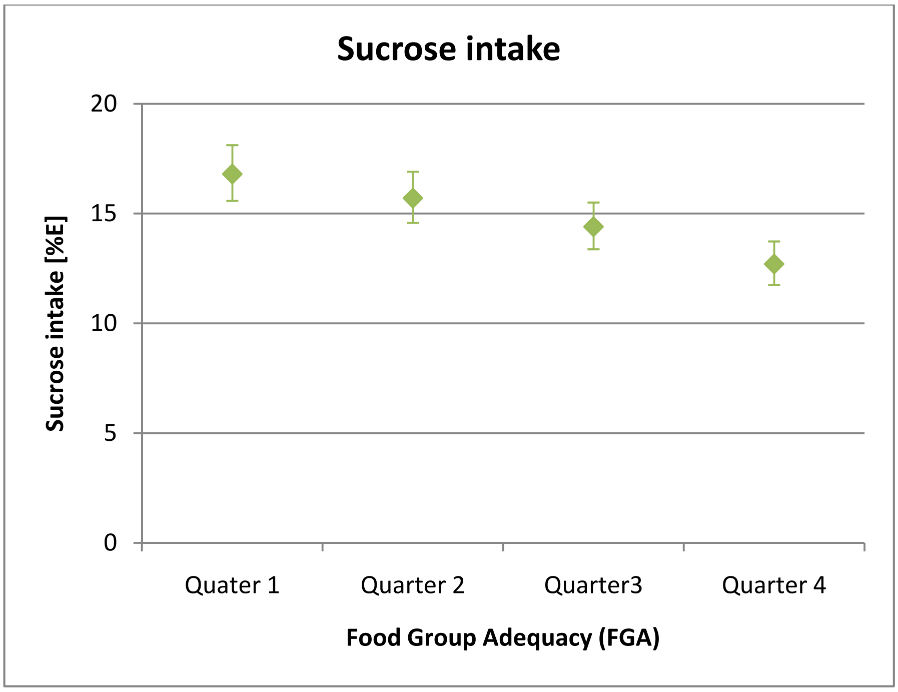

Figure 5 Sucrose intake [%E] by quarters of Food Group Adequacy (FGA), geometric means, adjusted for age, gender, BMI, and total food and beverage intake; error bars: 95%CI

A higher FGA showed no significant association with intake of energy, fat [%E], SFA [%E], or MUFA [%E], but it was associated with increased PUFA (17.8%E), cholesterol

(8.5%E), dietary fibre (33.9%E), and protein (5.5%E) intake. Furthermore, intake of total carbohydrates decreased significantly, although only by 2.7%E. However, decrease in carbohydrate intake was due to decreased sucrose intake (27.3%E).

Table 12 Geometric means of daily energy and macronutrient intakes by quarters of Food Group Adequacy (FGA), adjusted for age, gender, BMI, energy, and total food and beverage intake

	Food Group Adequacy						
	Quarter 1 (low diet quality)	Quarter 2	Quarter 3	Quarter 4 (high diet quality)	Adjusted R^2	P for trend	Δ 1-4 [%][1]
n (%) total=780	195 (25)	195 (25)	195 (25)	195 (25)			
FGA	0-396	533-817	466-533	533-817			
Energy [MJ][2]	6.66	6.50	6.65	6.44	.44	.296	-3.2
Fat [%E][3]	34.5	34.6	34.6	35.3	.07	.215	2.3
SFA [%E][3]	14.4	14.5	14.6	14.8	.03	.186	3.1
MUFA [%E][3]	12.1	12.1	11.9	12.1	.07	.773	-0.2
PUFA[%E][2]	5.5	5.8	6.0	6.1	.03	.002	10.6
Cholesterol [mg]	199	212	221	231	.41	<.001	16.0
CHO [E%][3]	50.9	51.1	50.4	49.5	.11	.045	-2.7
Sucrose [%E][2]	16.8	15.7	14.4	12.7	.11	<.001	-24.4
Dietary fibres [g]	11	13	14	16	.54	<.001	40.4
Protein [%E][2]	14.2	14.0	14.6	14.9	.09	.003	5.4

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA polyunsaturated fatty acids, CHO carbohydrates
[1]percent of change from quarter 1 to 4; [2]adjusted for age, gender, BMI, and total food and beverage intake; [3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake

Regarding associations between FGA and micronutrient intake, highest changes from Q1 to Q4 were seen in β-carotene (80.2%), vitamin A (47.7%), manganese (34.8%), vitamin D (31%), and folate (30.9%). No significant change could be observed for vitamin B1.

Table 13 Geometric means of daily micronutrient intakes by Food Group Adequacy (FGA) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake

	Food Group Adequacy						
	Quarter 1 (low diet quality)	Quarter 2	Quarter 3	Quarter 4 (high diet quality)	Adjusted R^2	P for trend	Δ 1-4 [%][1]
Vitamin A [µg][a]	0.49	0.58	0.65	0.72	0.28	<.001	47.7
β-Carotene [µg][b]	0.89	1.15	1.34	1.60	0.23	<.001	80.2
Vitamin D [µg]	1.00	1.19	1.23	1.34	0.22	<.001	33.3
Vitamin E [mg][c]	8.22	9.38	10.00	10.49	0.35	<.001	27.7
Vitamin B1 [mg]	0.82	0.85	0.81	0.87	0.47	.206	5.4
Vitamin B2 [mg]	1.02	1.09	1.13	1.15	0.46	<.001	13.0
Niacin [mg][d]	17.1	17.2	18.0	18.3	0.53	.002	6.9
Panthotenic acid [mg]	2.94	3.19	3.39	3.52	0.48	<.001	19.6
Vitamin B6 [mg]	0.96	0.99	1.04	1.10	0.41	<.001	14.6
Biotin [mg]	25.8	29.2	30.2	31.7	0.50	<.001	22.9
Folate [µg][e]	122.0	140.0	145.0	160.0	0.47	<.001	30.9
Vitamin B12 [µg]	2.99	3.16	3.25	3.48	0.31	<.001	16.5
Vitamin C [mg]	78.6	86.6	90.1	101.5	0.18	<.001	29.2
Sodium [mg]	2293	2448	2657	2804	0.43	<.001	22.3
Chloride [mg]	3656	3900	4235	4505	0.45	<.001	23.2
Potassium [mg]	1490	1631	1781	1917	0.59	<.001	28.6
Calcium [mg]	573	628	665	676	0.46	<.001	17.9
Phosphorus [mg]	813	862	912	951	0.65	<.001	17.0
Magnesium [mg]	190	207	219	228	0.65	<.001	20.4
Iron [mg]	7.87	8.23	8.43	8.71	0.64	<.001	10.7
Iodine [µg]	112	117	135	140	0.42	<.001	24.6
Zinc [mg]	6.98	7.46	7.77	8.04	0.65	<.001	15.1
Copper [mg]	1.24	1.34	1.38	1.44	0.72	<.001	15.8
Manganese [mg]	2.32	2.71	2.83	3.12	0.38	<.001	34.8

[1]percent of change from quarter 1 to 4
[a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

4.3 Between-Group Variety (BGV)

Two different scores of Between-Group Variety (BGV1 and BGV2) were calculated using different sets of minimum amounts for each food group (see section 3.7.1). Table 14 shows Spearman correlation coefficients of BGV1 and BGV2 with the deficient index, excess index, FGA, and energy intake. Correlations with the excess index and with energy were similar for BGV1 and BGV2, but associations with the deficient index and FGA were stronger for BGV1. This result was to be expected as BGV1 and FGA were based on the optimiX recommended amounts for food group consumption. Those recommendations are age and gender specific and were developed on the basis of the D-A-CH reference values for energy and nutrient intake. So, the deficient index, FGA, and BGV1 are based on the same values, and, therefore, showed strong correlations.

Table 14 Association between deficient index, excess index, Food Group Adequacy (FGA), and energy and Between-Group Variety (BGV) based on different minimum amounts (Spearman correlation coefficients) (n=741)

	Deficient Index	Excess Index	FGA	Energy
BGV1	.612*	-.297*	.497*	.365*
BGV2	.463*	-.299*	.344*	.355*

BGV1: Minimum amount of 25% of the recommended amount of the (optimiX)
BGV2: Minimum amount of 20 g/d for each food group but the group of oils, margarine, and butte, for which a minimum amount of 5 g was applied
*p<.05

4.3.1.1 Between-Group Variety 1 (BGV1)

BGV1 ranged from 2 to 10 with a median of 7 (IQR=2) (Figure 6 and Table 15). Boys (mean=7.1, SE=0.07) and girls (mean=7.0, SE=0.07) did not have significantly different BGV1 scores, $t(739)=0.813$, $p=.416$. There was no significant effect of BMI on BGV1, $F(3, 737)=2.49$, $p=.060$, but there was an effect of age on BGV1, $F(2, 738)=35\text{-}59$, $p<.001$. Younger children had a higher variety than older children (6-9 y: mean=7.5, SE=0.07; 10-12 y: mean=6.8, SE=0.08; 13-15 y: mean=6.5, SE=0.12).

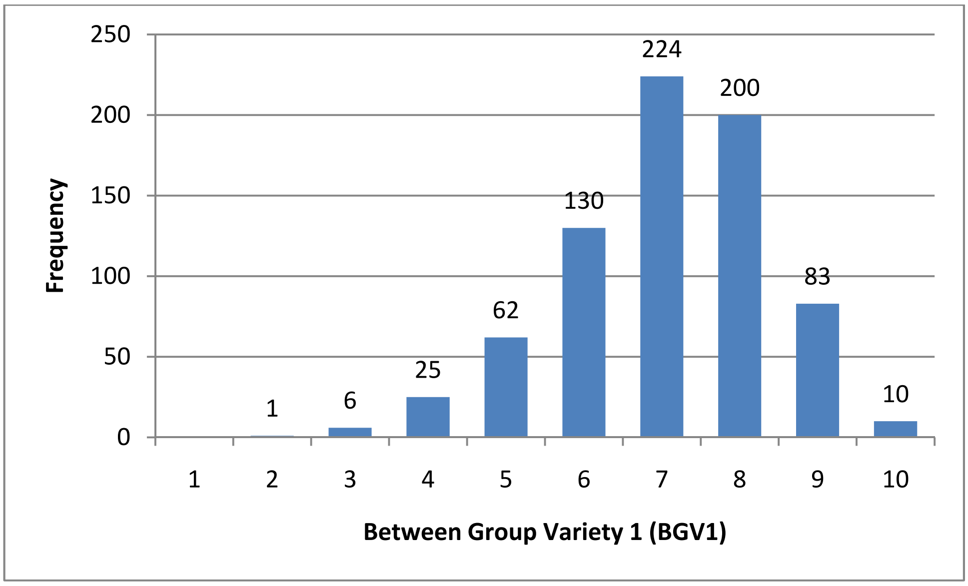

Figure 6 Frequency of Between-Group Variety (BGV1) scores in Austrian school children (n=780)

Table 15 Categories of Between-Group Variety 1 (BGV1) (n=741)

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	∑
BGV1	2-6	7	8	9-10	
Boys n (%)	107 (28.8)	115 (30.9)	100 (26.9)	50 (13.4)	372
Girls n (%)	117 (31.7)	109 (29.5)	100 (27.1)	43 (11.7)	369
Total n (%)	224 (30.2)	224 (30.2)	200 (27.0)	93 (12.6)	741

Regression models of 33 nutrients and energy were tested. The constant of the models represents the mean intake level of the tested nutrient in the first quarter of BGV1 for a boy at mean age, with mean energy intake, and mean BMI.

Table 16 and Table 17 show the changes from quarter 1 to 4, p-values, and adjusted R^2 for the linear regression models. Confidence intervals and values for all categories can be found in the annex (page 89).

Table 16 Geometric means of daily energy and macronutrient intakes by categories 1 and 4 of Between-Group Variety (BGV1), adjusted for age, gender, BMI, energy, and total food and beverage intake

	Between-Group Variety 1						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adjusted R^2	p for trend	Δ 1-4 [%][1]
n (%) total=741	224 (30.2)	224 (30.2)	200 (27.0)	93 (12.6)			
Energy [MJ][2]	6.11	6.66	6.99	6.92	.47	<.001	13.4
Fat [%E][3]	32.9	34.5	35.7	37.0	.11	<.001	12.4
SFA [%E][3]	13.9	14.5	14.9	15.7	.06	<.001	12.5
MUFA [%E][3]	11.5	12.0	12.4	12.6	.10	<.001	9.2
PUFA[%E][2]	5.3	5.9	6.2	6.4	.07	<.001	22.5
Cholesterol [mg]	192	213	221	283	.46	<.001	47.2
CHO [E%][3]	53.0	51.0	49.2	47.1	.17	<.001	-11.2
Sucrose [%E][2]	17.3	14.9	14.4	13.4	.10	<.001	-22.6
Protein [%E] [2]	12	14	14	15	.46	<.001	23.7
Dietary fibres [g]	13.7	14.1	14.8	15.8	.12	<.001	15.2

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA polyunsaturated fatty acids, CHO carbohydrates

[1]percent of change from quarter 1 to 4

[2]adjusted for age, gender, BMI, and total food and beverage intake

[3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake

Energy and 32 of the 33 tested nutrients showed significant change from quarter 1 to quarter 4. Total fat intake increased from quarter 1 to 4 significantly by 12.4%E from 32.9 to 37.0. Interestingly, intake of PUFA increased in a higher percentage (22.5%E) than MUFA (9.2%E) and SFA (12.5%E) (Figure 7). Intakes of carbohydrates and sucrose decreased significantly by 11.2%E and 22.6%E, respectively (Figure 8).

Regarding micronutrients, highest relative increases were found for β-carotene (97.0%), vitamin D (92.6%), and iodine (51.2%). As also shown for FGA, only thiamine did not show significant changes (Table 17).

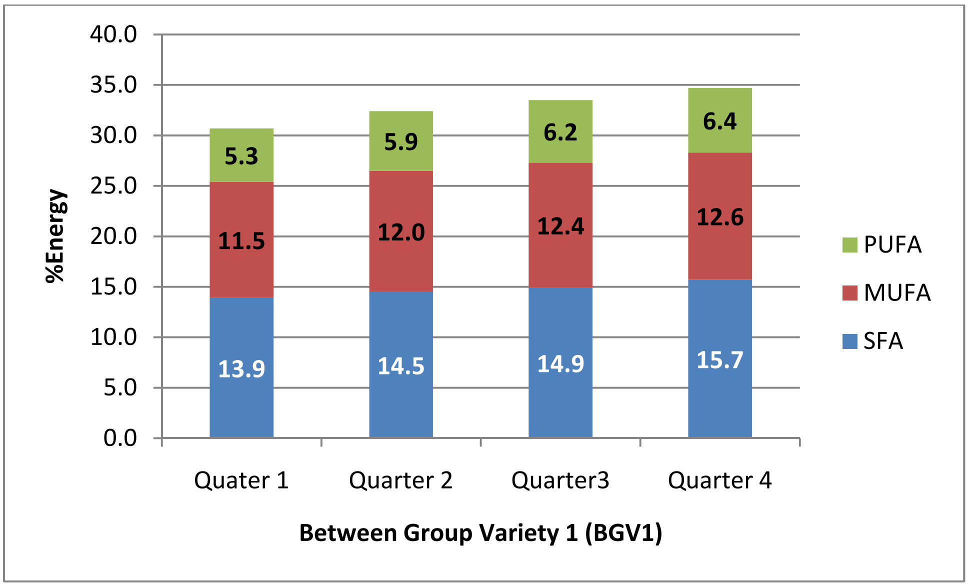

Figure 7 Intake of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA) by Between-Group Variety 1 (BGV1)

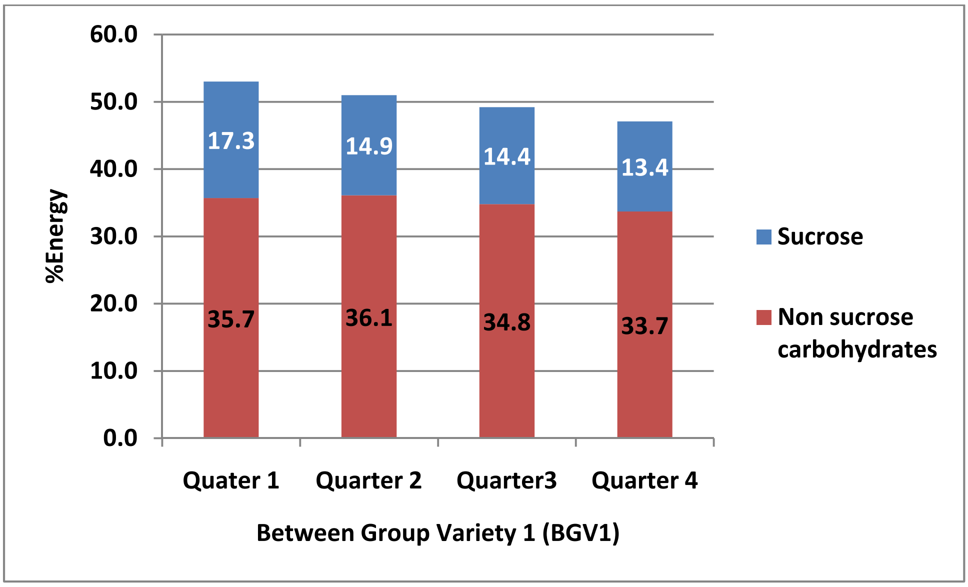

Figure 8 Carbohydrate intake (sucrose and non-sucrose) by quarters of Between-Group Variety 1 (BGV1)

Table 17 Geometric means of daily energy and micronutrient intakes by Between-Group Variety (BGV1) in categories 1 and 4, adjusted for age, gender, BMI, energy, and total food and beverage intake

	Between-Group Variety 1						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adj R-squared	p for trend	Δ 1-4 [%][1]
n (%) total=741	224 (30.2)	224 (30.2)	200 (27.0)	93 (12.6)			
Vitamin A [µg][a]	0.50	0.60	0.70	0.76	.28	<.001	50.7
Beta-Carotene [µg][b]	0.86	1.16	1.62	1.70	.26	<.001	97.0
Vitamin D [µg]	1.01	1.17	1.23	1.95	.28	<.001	92.6
Vitamin E [mg][c]	8.25	9.52	10.32	11.06	.36	<.001	34.1
Vitamin B1 [mg]	0.82	0.85	0.84	0.84	.47	.518	2.8
Vitamin B2 [mg]	1.07	1.07	1.12	1.18	.45	.004	10.9
Niacin [mg][d]	16.7	17.2	18.4	19.1	.54	<.001	14.8
Panthotenic acid [mg]	3.06	3.19	3.40	3.68	.46	<.001	20.5
Vitamin B6 [mg]	0.95	1.01	1.06	1.09	.40	<.001	14.6
Biotin [mg]	27.4	28.5	29.9	34.4	.48	<.001	25.6
Folate [µg][e]	125.0	142.0	148.0	164.0	.44	<.001	31.1
Vitamin B12 [µg]	2.88	3.10	3.50	4.16	.35	<.001	44.4
Vitamin C [mg]	72.5	90.1	96.4	107.2	.19	<.001	47.9
Sodium [mg]	2263	2575	2679	2838	.44	<.001	25.4
Chloride [mg]	3611	4115	4295	4520	.46	<.001	25.2
Potassium [mg]	1544	1677	1783	1904	.55	<.001	23.3
Calcium [mg]	618	636	640	704	.44	.002	13.9
Phosphorus [mg]	832	875	906	999	.64	<.001	20.1
Magnesium [mg]	199	210	217	223	.62	<.001	11.9
Iron [mg]	7.88	8.30	8.61	8.66	.64	<.001	9.9
Iodine [µg]	106	122	140	160	.49	<.001	51.2
Zinc [mg]	7.02	7.54	7.91	8.14	.65	<.001	15.8
Copper [mg]	1.28	1.35	1.39	1.39	.69	.001	8.1
Manganese [mg]	2.53	2.78	2.82	2.88	.32	.006	13.7

[1]percent of change from quarter 1 to 4
[a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

4.3.1.2 Between-Group Variety 2 (BGV2)

Median BGV2 was 8 (IQR=2) with a minimum of 4 and a maximum value of 10 (Table 19) Boys (mean=8.1, SE=0.05) and girls (mean=8.0, SE=0.05) did not have significantly different BGV2 scores, t(739)=1.8, p=.07. There was no significant effect of BMI on BGV2, F(3, 737)=.678, p=.566. As already seen for BGV1, BGV2 was significantly affected by age, F(2, 738)=4.0, p=.019). Younger children had a higher variety than older children (6-9 y: mean=8.2, SE=.06; 10-12 y: mean=8.0, SE=.06; 13-15 y: mean=8.0, SE=.09). Post hoc pair-wise comparisons showed that 6-9 years old children had significantly higher BGV2 scores than the 10-12 years olds (Gabriel´s post hoc test: p=.035).

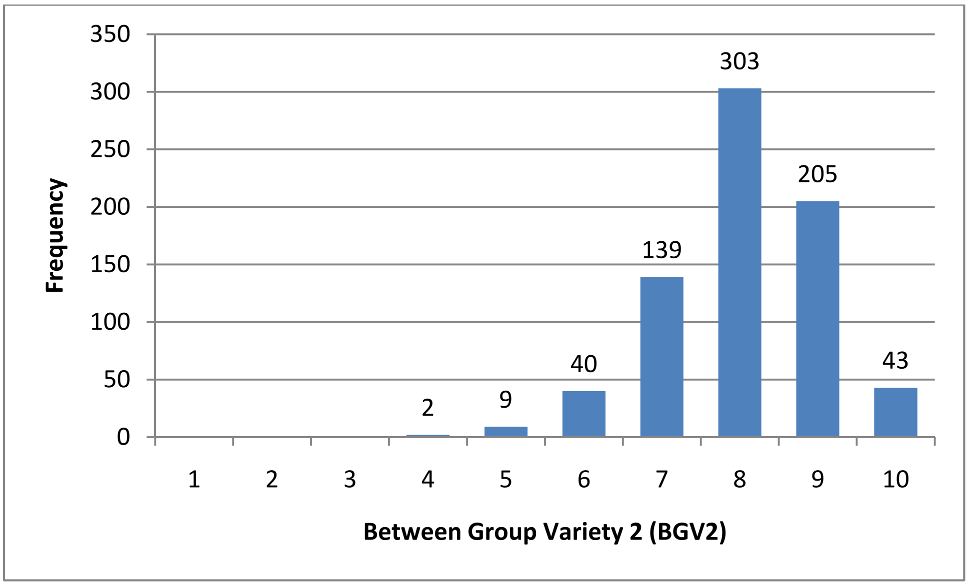

Figure 9 Frequency of Between-Group Variety (BGV2) scores in Austrian school children (n=741)

For further evaluation, data were categorised according to quartiles of BGV as shown in Table 18. Energy and 28 out of 33 tested nutrients showed significantly different intake levels from Q1 to Q4 (Table 19 and Table 20, confidence intervals see page 89ff).

Decreased intake in Q4 compared to Q1 was only observed for carbohydrates (decrease by 13%). Fat intake increased significantly by 12%. PUFA increased in a higher percentage than MUFA and SFA, but all three classes of fatty acids increased significantly. Carbohydrate intake decreased significantly by 13%. Also, sucrose intake decreased (by 9%), but this change was not statistically significant.

Table 18 Categories of Between-Group Variety 2 (BGV2) (n=741)

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Σ
BGV2 scores	4-7	8	9	10	
Boys n (%)	85 (22.9)	153 (41.1)	106 (28.5)	28 (7.5)	372
Girls n (%)	105 (28.5)	150 (40.7)	99 (26.8)	15 (4.1)	369
Total n (%)	190 (25.6)	303 (40.9)	205 (27.7)	43 (5.8)	741

Table 19 Geometric means (95% CI) of daily energy and macronutrient intakes by Between-Group Variety 2 (BGV2) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake, n=741

	Between-Group Variety 2						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adjusted R^2	p for trend	Δ 1-4 [%]
n (%) total=741	190 (25.6)	303 (40.9)	205 (27.7)	43 (5.8)			
Energy [MJ][2]	5.95	6.68	7.02	6.92	.49	<.001	16.3
Fat [%E][3]	32.7	34.4	36.1	37.1	.12	<.001	13.6
SFA [%E][3]	13.8	14.4	15.2	15.6	.06	<.001	12.8
MUFA [%E][3]	11.5	12.0	12.5	12.4	.10	.008	7.9
PUFA[%E][2]	5.2	5.8	6.1	6.9	.07	<.001	32.0
Cholesterol [mg]	178	201	265	300	.54	<.001	68.1
CHO [E%][3]	53.1	51.2	48.6	47.2	.17	<.001	-11.2
Sucrose [%E][2]	16.1	15.3	14.5	14.8	.08	.195	-8.1
Dietary fibres [g]	12	14	13	14	.43	.016	12.8
Protein [%E] [2]	13.8	14.1	14.9	15.6	.10	<.001	12.7

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]percent of change from quarter 1 to 4
[2]adjusted for age, gender, BMI, and total food and beverage intake
[3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake

Highest relative increase from Q1-Q4 was observed for vitamin D (64%), β-carotene (40%), and vitamin B12 (38%). Only vitamin B1, calcium, copper, and manganese showed no increased intake.

Table 20 Geometric means (95% CI) of daily micronutrient intakes by Between-Group Variety 2 (BGV2) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake

	Between-Group Variety 2						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adj R-squared	p for trend	Δ 1-4 [%][1]
n (%) total=741	190 (25.6)	303 (40.9)	205 (27.7)	43 (5.8)			
Vitamin A [µg][a]	0.51	0.61	0.70	0.70	.27	<.001	39.5
Beta-Carotene [µg][b]	0.85	1.30	1.45	1.43	.23	<.001	67.1
Vitamin D [µg]	0.86	1.09	1.65	2.38	.40	<.001	177.0
Vitamin E [mg][c]	8.20	9.61	10.02	11.89	.36	<.001	45.0
Vitamin B1 [mg]	0.82	0.85	0.82	0.85	.47	.626	3.8
Vitamin B2 [mg]	1.04	1.12	1.10	1.17	.45	.043	11.9
Niacin [mg][d]	16.5	17.6	18.1	19.4	.54	<.001	17.6
Panthotenic acid [mg]	2.99	3.30	3.36	3.63	.46	<.001	21.2
Vitamin B6 [mg]	0.94	1.04	1.02	1.12	.40	.001	19.6
Biotin [mg]	26.1	29.2	31.1	34.2	.49	<.001	31.3
Folate [µg][e]	125.0	145.0	145.0	157.0	.43	<.001	25.8
Vitamin B12 [µg]	2.75	3.12	3.73	4.42	.38	<.001	61.0
Vitamin C [mg]	71.1	92.3	96.3	95.6	.19	.006	34.4
Sodium [mg]	2361	2546	2631	2694	.41	.001	14.1
Chloride [mg]	3757	4081	4188	4354	.42	<.001	15.9
Potassium [mg]	1535	1725	1745	1833	.54	<.001	19.4
Calcium [mg]	618	652	636	660	.44	.306	6.7
Phosphorus [mg]	836	888	909	947	.63	<.001	13.3
Magnesium [mg]	202	213	210	218	.61	.040	8.0
Iron [mg]	7.81	8.43	8.49	8.50	.64	.009	8.8
Iodine [µg]	106	121	142	169	.48	<.001	58.8
Zinc [mg]	7.14	7.60	7.77	7.81	.63	.003	9.5
Copper [mg]	1.30	1.37	1.35	1.37	.69	.109	5.6
Manganese [mg]	2.60	2.80	2.69	2.83	.31	.242	8.9

[1]percent of change from quarter 1 to 4
[a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

4.4 Fruit and Vegetable Variety (FVV)

Fruit and Vegetable Variety (FVV) ranged from 0 to 12 with a median of 3 (IQR=3) and both, Fruit Variety (FV) (median=2, IQR=2) and Vegetable Variety (VV) (median=1, IQR=2) ranged from 0 to 8. Descriptive statistics are given in Table 21. FV contributed more to FVV than VV as it was higher in the total population as well as in gender, age, and BMI class specific subgroups.

FVV scores were not significantly different between boys (mean=3.4, SE=0.11) and girls (mean=3.5, SE=0.10), t=-0.928, p=.354. No effect of BMI (F(3, 737)=0.84, p=.472) and age (F(2,738)=2.21, p=.111) on FVV could be observed.

Table 21 Fruit and Vegetable Variety (FVV), Fruit Variety (FV), and Vegetable Variety (VV) in Austrian school children

	FVV		FV		VV	
	Mean (SE)	Median (IQR)	Mean (SE)	Median (IQR)	Mean (SE)	Median (IQR)
Total (n=741)	3.47 (0.07)	3 (3)	2.17 (0.05)	2 (2)	1.30 (0.05)	1 (2)
Gender						
Boys (n=372)	3.41 (0.11)	3 (3)	2.03 (0.07)	2 (2)	1.38 (0.07)	1 (2)
Girls (n=369)	3.54 (0.10)	3 (3)	2.31 (0.07)	2 (2)	1.23 (0.07)	1 (2)
Age						
6-9 y (n=304)	3.64 (0.11)	3 (3)	2.27 (0.07)	2 (2)	1.37 (0.08)	1 (2)
10-12 y (n=297)	3.41 (0.12)	3 (3)	2.16 (0.08)	2 (2)	1.25 (0.08)	1 (2)
13-15 y (n=140)	3.24 (0.17)	3 (2)	1.97 (0.11)	2 (2)	1.26 (0.11)	1 (2)
BMI classes						
Underweight (n=45)	3.36 (0.26)	3 (3)	2.29 (0.21)	2 (2)	1.07 (0.18)	1 (2)
Normal weight (n=574)	3.53 (0.09)	3 (3)	2.20 (0.06)	2 (2)	1.33 (0.06)	1 (2)
Overweight (n=78)	3.38 (0.22)	3 (3)	2.08 (0.15)	2 (2)	1.31 (0.15)	1 (2)
Obese (n=44)	3.07 (0.25)	3 (2)	1.91 (0.18)	3 (2)	1.16 (0.19)	1 (2)

Fruit and Vegetable Variety as well as fruit variety and vegetable variety correlated significantly with measures of diet quality as well as BGV1 and BGV2. Coefficients are given in Table 22. Correlation coefficients are similar for FVV, FV, and VV, but by trend stronger for FVV than FV or VV. As expected, fruit and vegetable intake increased with Fruit and Vegetable Variety (Table 24). Therefore, total fruit and vegetable amount consumed was introduced into the regression model as an independent variable.

Table 22 Associations of Fruit and Vegetable Variety (FVV), Fruit Variety (FV), and Vegetable Variety (VV) with different measures of diet quality and dietary variety (n=741)

	FVV	FV	VV
Deficient Index	.464*	.333*	.369*
Excess Index	-.194*	-.095*	-.204*
FGA	.444*	.375*	.283*
BGV1	.435*	.277*	.397*
BGV2	.277*	.189*	.228*
Energy	.236*	.143*	.223*

* p<.001

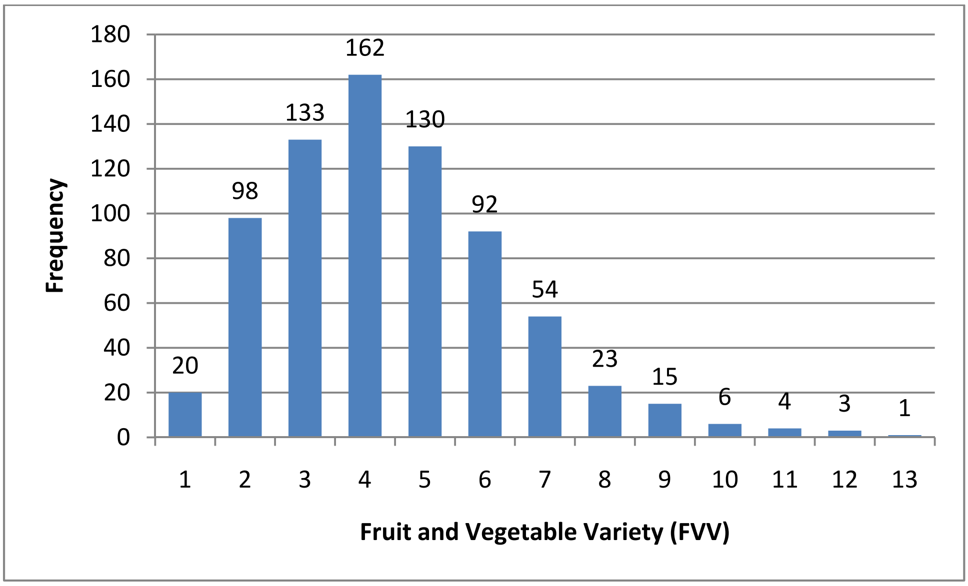

Figure 10 Frequency of Fruit and Vegetable Variety Scores in Austrian school children (n=741)

Table 23 Categories of Fruit and Vegetable Variety (FVV) (n=721)

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Σ
FVV scores	4-7	8	9	10	
Boys n (%)	218 (34.4)	73 (19.6)	101 (27.2)	57 (15.3)	359
Girls n (%)	103 (27.9)	89 (24.1)	121 (32.8)	49 (13.3)	362
Total n (%)	231 (31.2)	162 (21.9)	222 (30.0)	106 (14.3)	721

Table 24 Fruit and vegetable intake [g] by Fruit and Vegetable Variety categories (n=721)

	Fruit and Vegetable Variety	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)
Fruit and vegetable intake [g]	Mean (SE)	207 (10.4)	340 (15.7)	428 (18.7)	530 (17.7)
	Median (IQR)	169 (134)	270 (204)	375 (220)	497 (225)

Energy and 23 out of 33 tested nutrients showed significant changes from Q1 to Q4. Energy intake increased significantly from quarter 1 to 4, but only by 8%. No significant increase of fat intake was observed, but significant increase of PUFA by 8%.

Table 25 Geometric means of daily energy and nutrient intakes by Fruit and Vegetable Variety (FVV) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake (n=721)

	Fruit and Vegetable Variety						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adjusted R^2	p for trend	Δ 1-4 [%]
n (%) total=721	231 (31.2)	162 (21.9)	222 (30.0)	106 (14.3)			
Energy [MJ][2]	6.61	6.67	6.93	7.18	.16	.006	8.6
Fat [%E][3]	34.5	33.6	34.3	35.4	.06	.163	2.6
SFA [%E][3]	14.3	14.2	14.8	14.8	.05	.139	3.0
MUFA [%E][3]	12.1	11.7	11.9	12.0	.08	.995	-0.5
PUFA[%E][2]	5.8	5.6	5.5	6.4	.02	.032	10.3
Cholesterol [mg]	217	214	209	212	.39	.545	-2.2
CHO [E%][3]	50.6	51.8	51.5	49.8	.08	.350	-1.6
Sucrose [%E][2]	14.8	15.8	16.7	15.7	.02	.226	6.1
Dietary fibres [g]	12	13	14	16	.47	<.001	33.7
Protein [%E] [2]	14.5	14.2	13.9	14.6	.05	.932	1.0

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA polyunsaturated fatty acids, CHO carbohydrates
[1]percent of change from quarter 1 to 4
[2]adjusted for age, gender, BMI, and total fruit and vegetable intake
[3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake

Highest increases of micronutrients from Q1 to Q4 were observed for β-carotene (61%), vitamin A (39%), and vitamin C. Vitamin D, B1, and B12 did not show significant changes.

Table 26 Table 27 Geometric means (95% CI) of daily energy and nutrient intakes by Fruit and Vegetable Variety (FVV) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake (n=721)

	Fruit and Vegetable Variety						
	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adjusted R^2	p for trend	Δ 1-4 [%][1]
n (%) total=721	231 (31.2)	162 (21.9)	222 (30.0)	106 (14.3)			
Vitamin A [µg][a]	0.51	0.61	0.68	0.84	.31	<.001	64.5
Beta-Carotene [µg][b]	0.87	1.19	1.61	2.24	.38	<.001	157.0
Vitamin D [µg]	1.21	1.13	1.20	1.23	.20	.661	1.3
Vitamin E [mg][c]	9.18	9.33	9.46	10.95	.35	<.001	19.3
Vitamin B1 [mg]	0.86	0.83	0.82	0.85	.47	.655	-1.3
Vitamin B2 [mg]	1.09	1.10	1.10	1.18	.45	.052	8.4
Niacin [mg][d]	17.5	17.5	17.4	18.8	.53	.032	7.4
Panthotenic acid [mg]	3.15	3.31	3.32	3.68	.51	<.001	16.8
Vitamin B6 [mg]	0.97	1.02	1.05	1.18	.48	<.001	22.1
Biotin [mg]	28.6	29.0	30.3	32.3	.52	<.001	13.1
Folate [µg][e]	134.0	139.0	153.0	158.0	.50	<.001	17.3
Vitamin B12 [µg]	3.32	3.25	3.10	3.27	.30	.555	-1.6
Vitamin C [mg]	79.2	94.7	103.3	116.9	.39	<.001	47.5
Sodium [mg]	2425	2516	2588	2643	.40	.005	9.0
Chloride [mg]	3861	4014	4155	4281	.41	.001	10.9
Potassium [mg]	1627	1709	1794	1914	.71	<.001	17.6
Calcium [mg]	623	650	659	681	.43	.027	9.4
Phosphorus [mg]	880	867	889	933	.62	.014	6.0
Magnesium [mg]	205	210	218	228	.65	<.001	11.0
Iron [mg]	8.14	8.46	8.40	8.88	.65	.001	9.1
Iodine [µg]	118	127	131	135	.27	<.001	14.7
Zinc [mg]	7.40	7.46	7.55	8.09	.63	<.001	9.2
Copper [mg]	1.31	1.36	1.39	1.42	.63	.001	8.6
Manganese [mg]	2.58	2.65	2.88	3.04	.31	<.001	17.7

[1]percent of change from quarter 1 to 4
[a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

4.5 Comparison of Food Group Adequacy (FGA), Between-Group Variety 1 and 2 (BGV1 and BGV2), and Fruit and Vegetable Variety (FVV)

In the sections above, the associations between energy and nutrient intake and FGA, BGV, and FVV were described. The following chapter will compare those measures. Table 28 gives an overview of bivariate Spearman correlation coefficients between different scores, the deficient and excess index, and energy intake.

FGA showed lowest correlations with the deficient and the excess index as well as with energy intake. BGV1 shows the strongest association with the deficient index. The correlation between excess index and energy intake for FVV was weaker than for both BGV scores.

Table 28 Spearman correlation coefficients for Food Group Adequacy (FGA), Between-Group Variety (BGV1 and BGV2), and Fruit and Vegetable Variety (FVV) with deficient index, excess index and energy intake

	Deficient index	Excess index	Energy intake
FGA (n=780)	.422*	-.064	.159*
BGV1 (n=741)	.618*	-.305*	.350*
BGV2 (n=741)	.502*	-.307*	.340*
FVV (n=741)	.444*	-.214*	.237*

*: p<.05

Figure 11 to Figure 14 show the relative changes [%] of energy and nutrient intake from Q1 to Q4 for FGA, BGV1, BGV2, and FVV, derived from regression models. FGA was the only score not associated with higher energy intake. This shows that a higher diet quality can be achieved without necessarily increasing energy intake. FVV was significantly associated with higher energy intake, but not as strongly as BGV1 and BGV2.

BGV1 and BGV2 showed very similar associations with macronutrients. The extent of the intake increase of energy, fat, SFA, MFA, PUFA, cholesterol, dietary fibres, and protein and the decrease of carbohydrates were comparable. Sucrose intake is the only exception: intake decreased significantly with BGV1 but not with BGV2, although changes in total carbohydrates were very similar for those two indexes.

FGA and FVV were, in contrast to BGV1 and BGV2, not significantly associated with fat, SFA, MUFA, cholesterol, carbohydrate, and protein intake, but they were also associated with higher PUFA and dietary fibre intake. FGA and FVV showed similar associations regarding macronutrient intake with the exception of sucrose intake which decreased significantly with FGA, but did not change significantly with FVV.

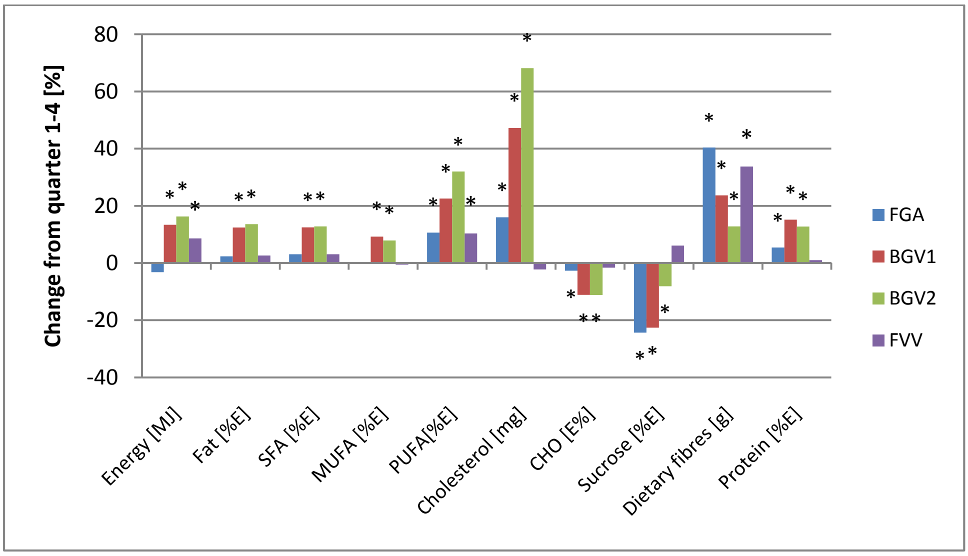

Figure 11 Changes in energy and macronutrient intakes from quarter 1 (Q1) to 4 (Q4) of Food Group Adequacy (FGA, n=780), Between-Group Variety 1 (BGV1, n=741), Between-Group Variety 2 (BGV2, n=741), and Fruit and Vegetable Variety (FVV, n=721), *: p<.05

Intake of tested fat-soluble vitamins showed higher intakes with all four scores except for vitamin D, which did not increase with FVV quarters (Figure 12). The increase of β-carotene was about twice as high for FVV compared to FGA, BGV1, and BGV2; the increase of vitamin D intake was twice as high for BGV2 as compared to BGV1 and ten times as high as compared to FGA.

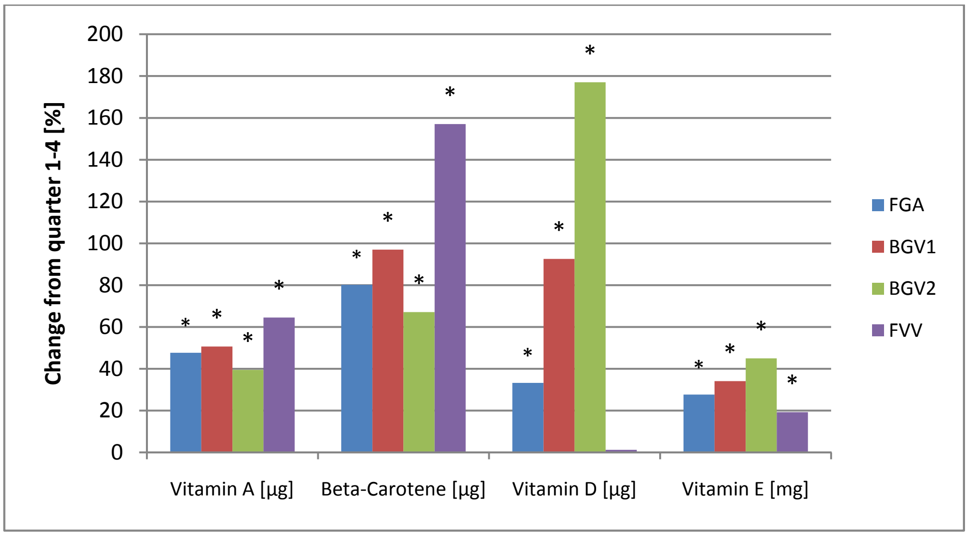

Figure 12 Changes in fat-soluble vitamin intakes from quarter 1 (Q1) to 4 (Q4) of Food Group Adequacy (FGA, n=780), Between-Group Variety 1 (BGV1, n=741), Between-Group Variety 2 (BGV2, n=741), and Fruit and Vegetable Variety (FVV, n=721), *: p<.05

Most of the water-soluble vitamins changed significantly from Q1 to Q4 (Figure 13). Only vitamin B1 intakes did not change with all four indexes. Vitamin B2 increased significantly only with BGV2 and vitamin B12 was not changed for FGA and FVV but showed significantly increase to a similar extent with BGV1 and BGV2.

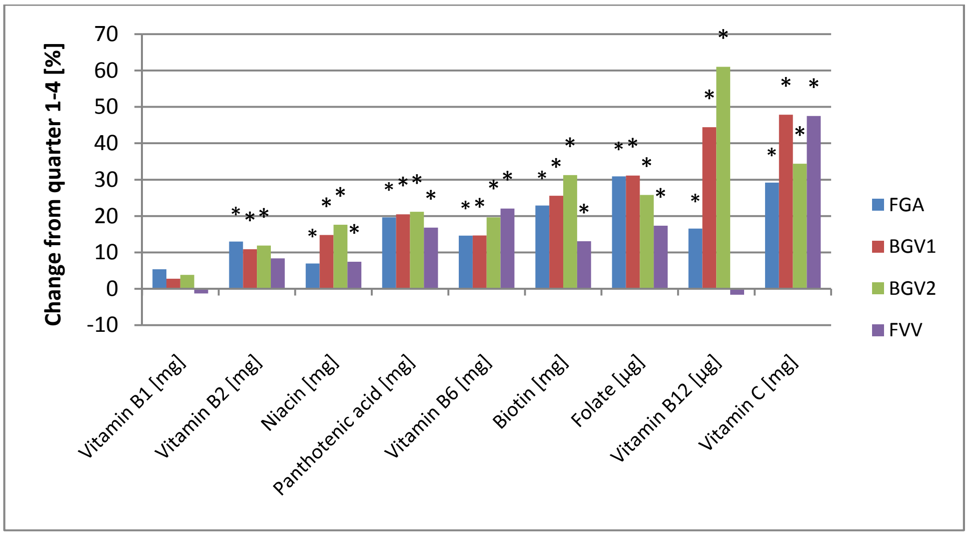

Figure 13 Changes in water-soluble vitamin intakes from quarter 1 (Q1) to 4 (Q4) of Food Group Adequacy (FGA, n=780), Between-Group Variety 1 (BGV1, n=741), Between-Group Variety 2 (BGV2, n=741), and Fruit and Vegetable Variety (FVV, n=721), *: p<.05

With the exception of calcium, all minerals showed increased intake with higher scores. Calcium only increased significantly for FVV, but nor for the other indices. Manganese and copper intake increased significantly for all indexes but BGV2. Iodine showed the highest relative increases for BGV1 and BGV2 which was about three to four times as high as the increase for FGA and FVV.

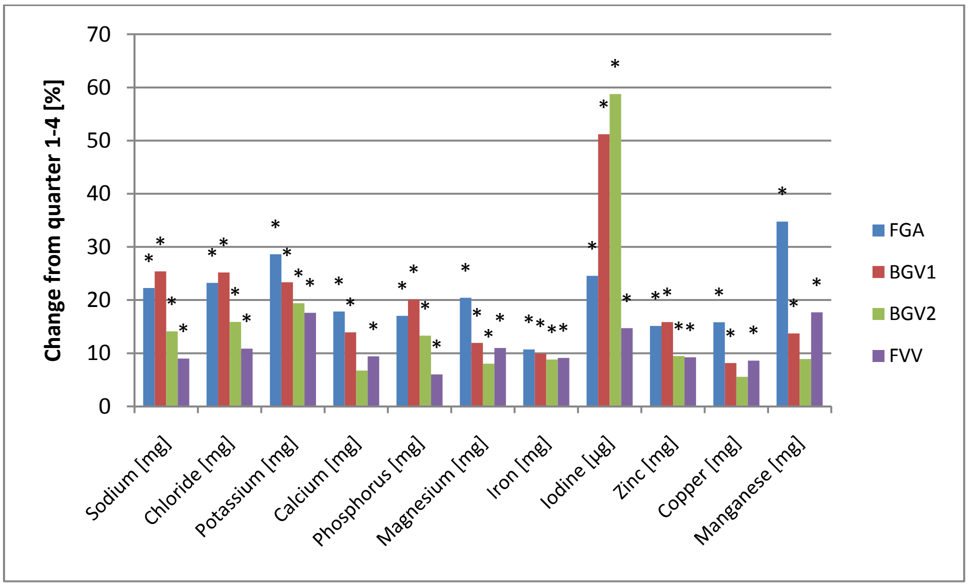

Figure 14 Changes in mineral intakes from quarter 1 (Q1) to 4 (Q4) of Food Group Adequacy (FGA, n=780), Between-Group Variety 1 (BGV1, n=741), Between-Group Variety 2 (BGV2, n=741), and Fruit and Vegetable Variety (FVV, n=721), *: p<.05

4.6 Which Food Groups Contribute to FGA, BGV1, and BGV2?

BGV1, BGV2, and FGA are based on 10 and 11 food groups, respectively. A question not discussed up to here is, which food groups contribute to those indexes. In order to get a better picture of BGV1 and BGV2, the percentage of persons, for which respective food groups contributed to variety, was calculated.

Regarding BGV1, the food groups meat and sausages and oil/butter/margarine contributed for most children to the variety score (95% and 91%, respectively), whereas for BGV2 it was shown that bread, potatoes, rice, and cereals, and milk and milk products contributed to the variety score for most children (98%). The lowest percentages were shown for eggs (16% BGV1 and 32% BGV2) and fish (22% BGV1 and 23% BGV2). Data also demonstrate how the different used minimum amounts effect whether a food group contributed to the variety score or not. For the food group vegetables, for example, 59% of children were assigned a variety point for BGV1 but a much higher percentage of 89% of children got a variety point for BGV2 (Table 29). This is due to the lower minimum amount of 20 g/d for vegetables in BGV2 compared to the minimum amount of a quarter of the recommended amount in BGV1 (between 55 g/d and 60 g/d depending on age and gender). The food group oil/butter/margarine showed the biggest difference: 90% of children consumed more than the minimum amount used for BGV1 but only 40% for BGV2. This is the only food group, where minimum amounts were smaller for BGV1 than for BGV2.

Table 29 Percentage of children, for whom a food group contributed to Between-Group Variety 1 (BGV1) and Between-Group Variety 2 (BGV2) (n=741)

	BGV1 %	BGV2 %
Beverages	85	97
Vegetables	59	89
Fruit	85	92
Potatoes, rice, other cereals	81	98
Milk and -products	91	97
Meat, sausages	95	93
Eggs	16	32
Fish	21	23
Oil, butter, margarine	90	40
Bread, cereal flakes	81	98

To see, whether there was a difference between the contributions of food groups to variety scores for children with low and high variety, the contribution was also calculated for quarters of BGV1 and BGV2 (Figure 15 and Figure 16). In general, lower quarters of BGV showed a lower percentage of children. For BGV1, the biggest differences between quarter 1 and 4 were seen for the food groups vegetables, fish, and eggs. For fish and eggs, it is noticeable, that quarters 1 to 3 are quite similar, and only quarter 4 was higher. Only small differences were seen for meat and sausages and for milk and milk products.

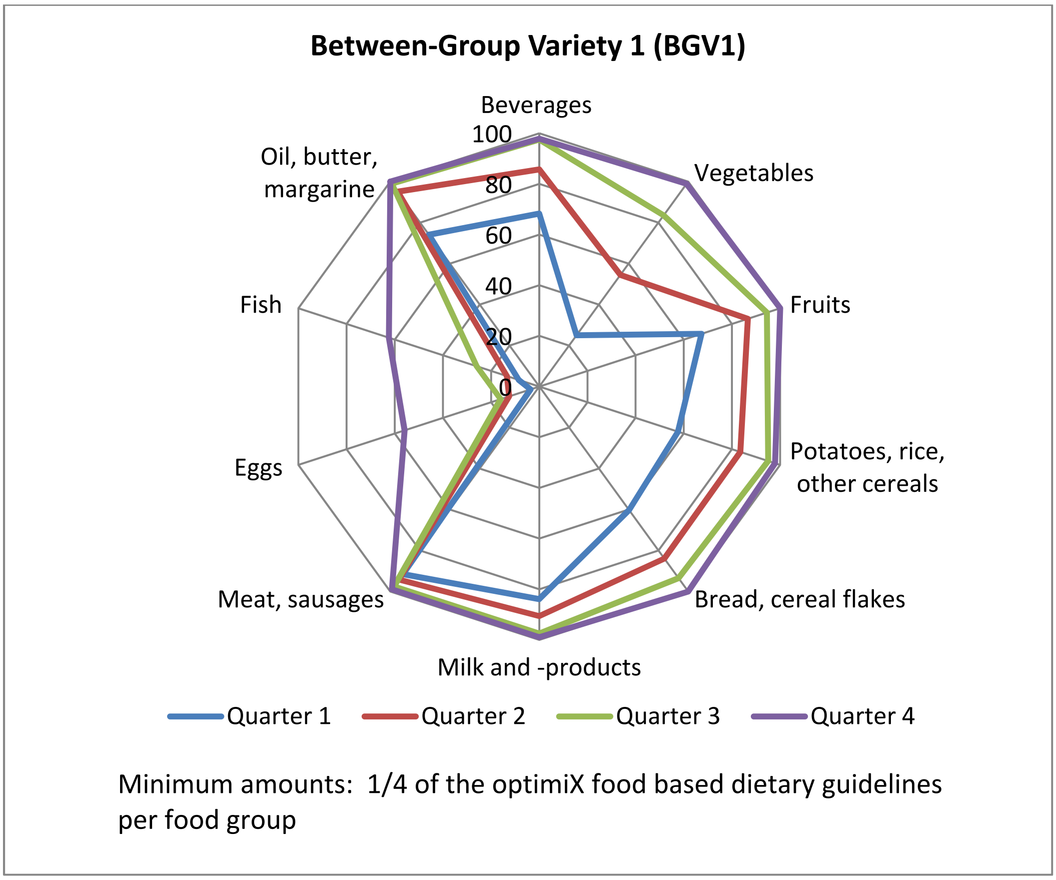

Figure 15 Percentage of children consuming food groups in amounts exceeding the minimum amounts by quarters of Between-Group Variety 1 (BGV1) (n=741)

As for BGV1, also for BGV2 the food groups fish and eggs showed the biggest differences in the contribution to the variety score. Also oils/butter/margarine, vegetables, and fruits were consumed from a considerably lower percentage of children from Q1 compared to Q4. Differences between Q1 and Q4 were in most cases lower for BGV2 compared to BGV1: for BGV1 bread and cereals, beverages, potatoes, milk and milk products, and meat and sausages differed only by less than 20% between Q1 and Q4; regarding BGV1, this is only true for milk and milk products and meat and sausages.

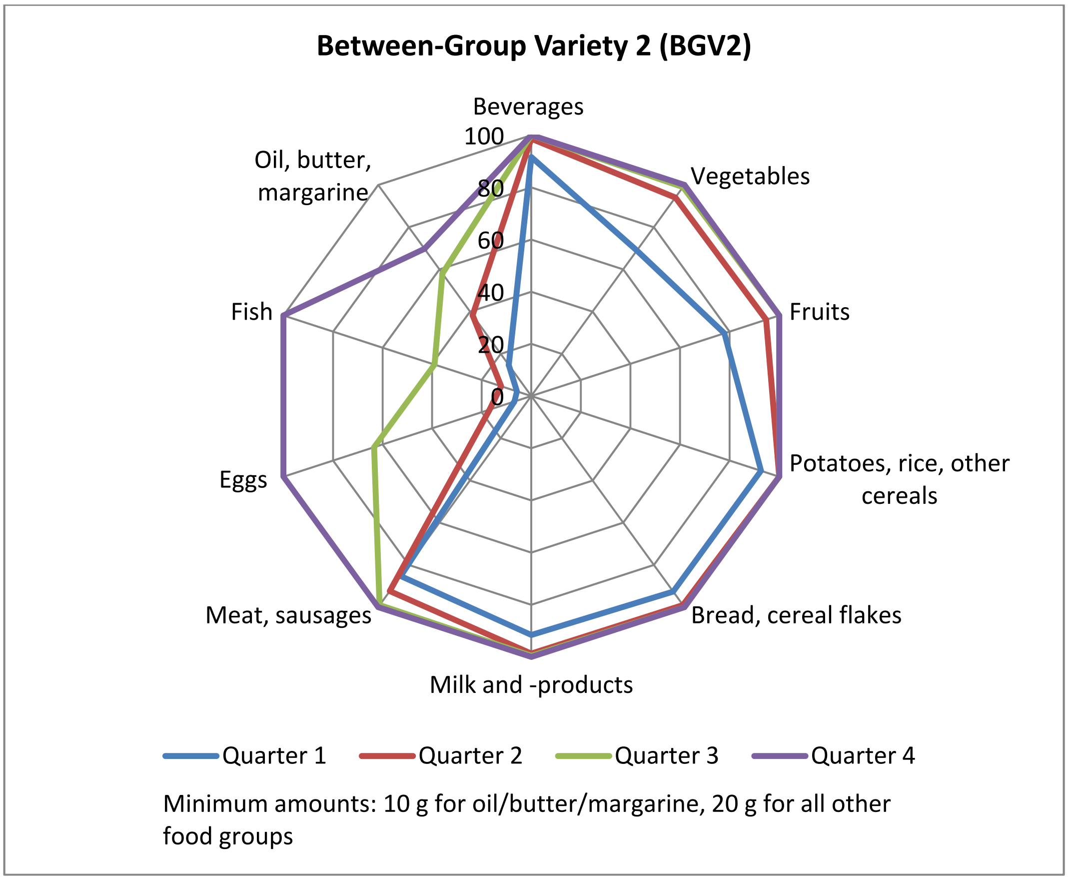

Figure 16 Percentage of children consuming food groups in amounts exceeding the minimum amounts by quarters of Between-Group Variety 2 (BGV2) (n=741)

Figure 17 shows the mean intake of food groups for the whole sample and also divided quarters of FGA. Intake amounts are presented as differences from the mean intake of the whole sample.

Most food groups showed lower intake levels in Q1 compared to Q4. Exceptions were tolerated foods and milk and milk products. Bread, oil/margarine/fat, fish, eggs, and meat and meat products showed similar intake levels from Q1 to Q4. The group of beverages showed the biggest deviations from the mean intake, with Q4 showing the highest intake and Q1 the smallest. Vegetables, fruits, and the group of potatoes, rice and other cereals showed considerable differences from Q1 to Q4.

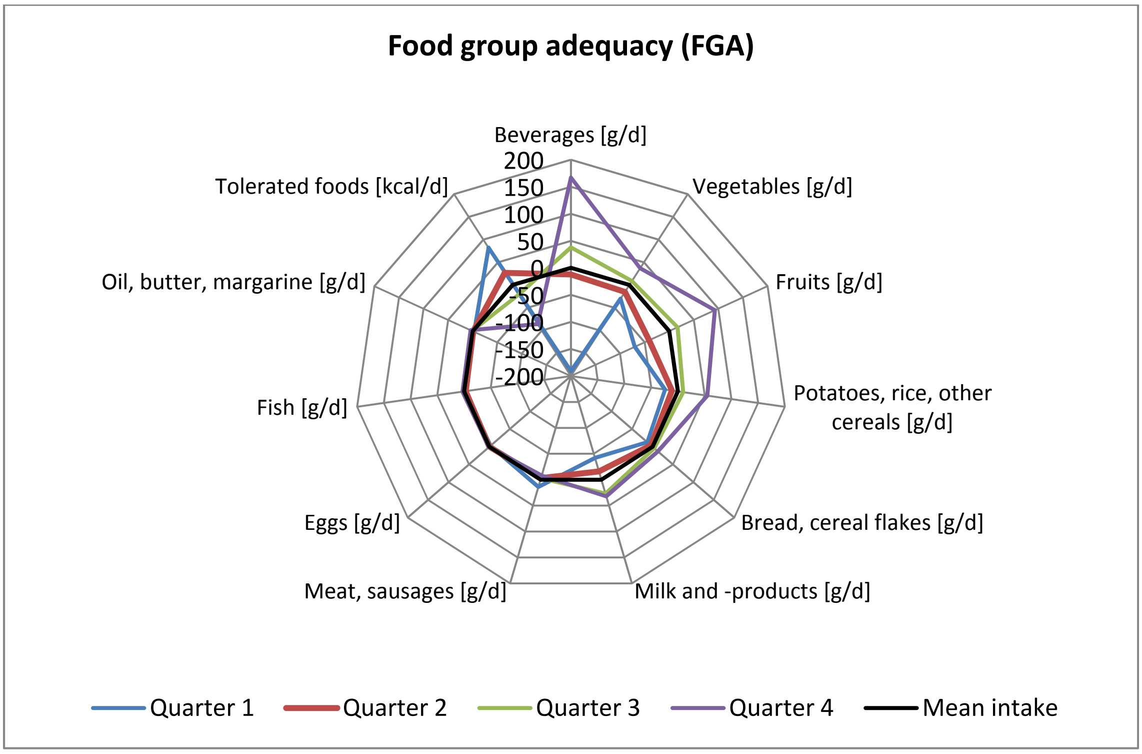

Figure 17 Mean consumption of food groups [g] by quarters of Food Group Adequacy (FGA) given as difference from the mean consumption of the whole sample (n=780)

4.7 Sensitivity Analysis

A sensitivity analysis was conducted to study whether the exclusion of mis-reporters at different levels yields different results (see section 3.4.2). Exemplarily, results are presented for FVV and energy

intake as well as for selected nutrients. Table 30 and

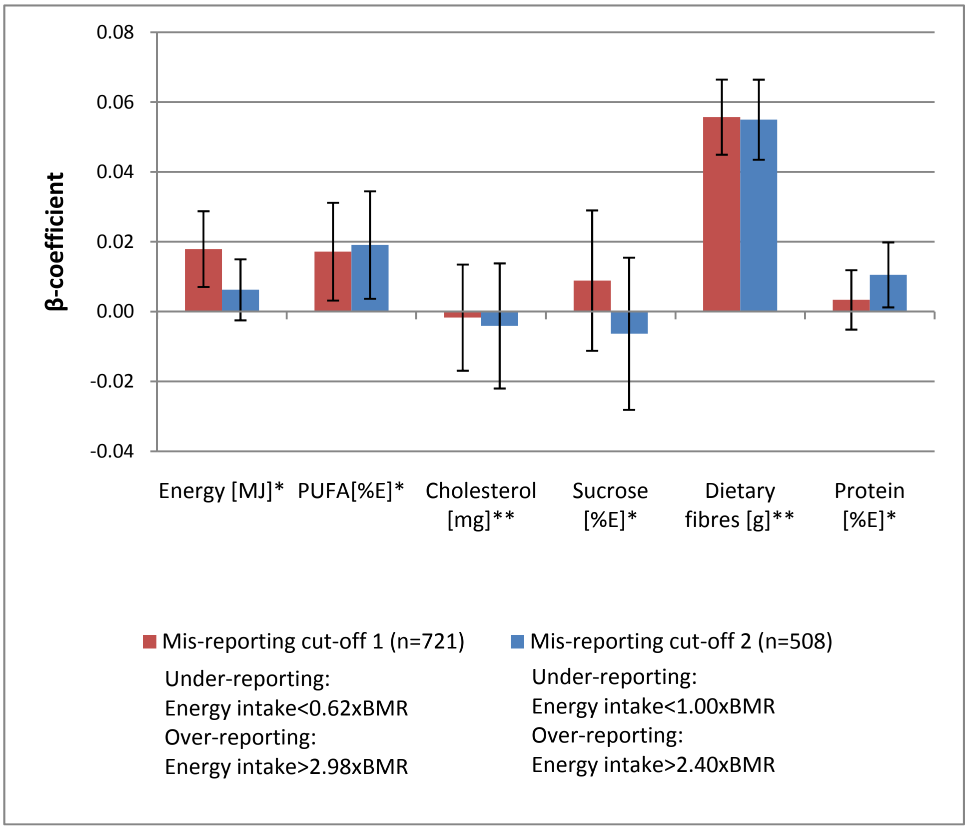

Figure 18 show the β-coefficients derived from multiple linear regression models which were adjusted for total energy intake, age, gender, BMI, and fruit and vegetable intake. The 95% confidence intervals do not show significant differences between β-coefficients from mis-reporter cut-off 1 and cut-off 2. Thus, the regression models are robust against different mis-reporter cut-offs.

Data for FGA, BGV1, BGV2, and FVV are attached in the Annex (p 96ff). All results considered, robustness of the regression models against different mis-reporter cut-offs can be assumed. Furthermore, when stratifying for age and gender, results remain the same with only some minor exceptions (Table 35-40, p 95ff).

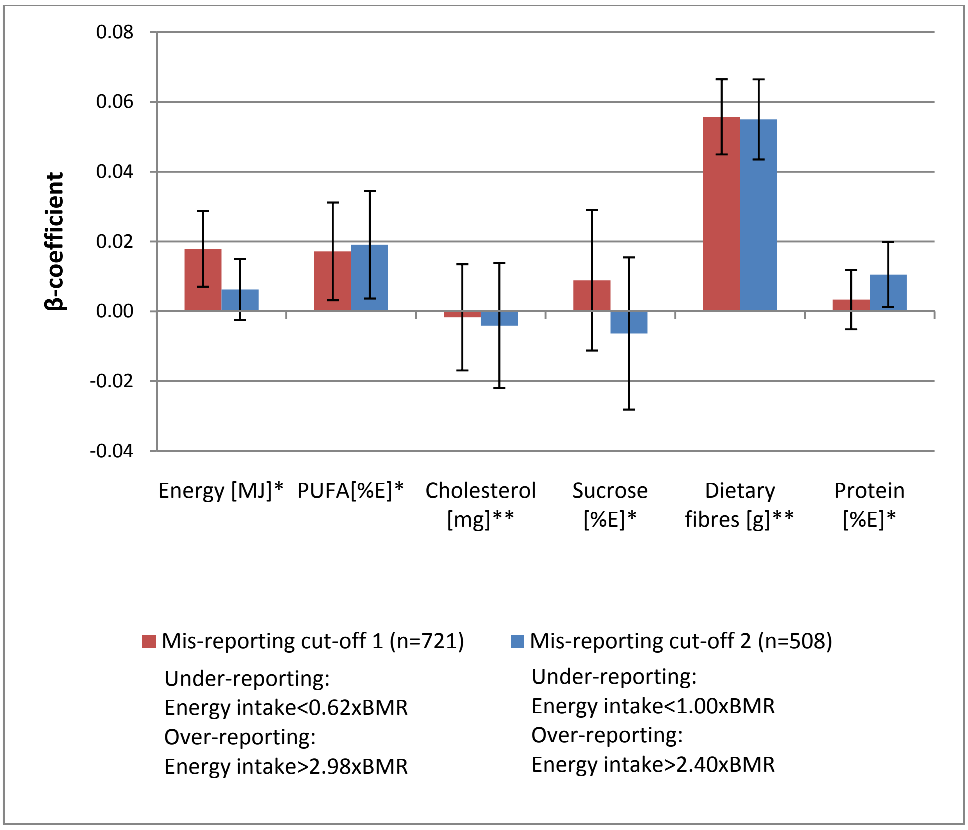

Figure 18 Sensitivity analyses for Fruit and Vegetable Variety (FVV) and different cut-offs for mis-reporting (under- and over-reporting): β-coefficients of energy and selected nutrients derived from multiple linear regression; error bars: 95% confidence intervals; data presented on the transformed scale (natural logarithm); *adjusted for, age, gender, BMI, and total fruit and vegetable intake **adjusted for total energy intake, age, gender, BMI, and total fruit and vegetable intake

Table 30 Sensitivity analyses for Fruit and Vegetable Variety (FVV) and different cut-offs for mis-reporting (under- and over-reporting) and stratification for age and gender: β-coefficients of energy and selected nutrients derived from multiple linear regression models

	Mis-reporter cut-off 1	Mis-reporter cut-off 2	Age 6-9 y	Age 10-12 y	Age 13-15 y	Boys	Girls
n	721	508	296	287	138	359	362
Energy [MJ]*,[1]	0.02 (0.01;0.03)	0.01 (0;0.01)	0.02 (0;0.04)	0.01 (-0.01;0.03)	0.02 (0;0.05)	0.02 (0;0.03)	0.02 (0;0.03)
Fat [%E]*	0.19 (-0.07;0.45)	0.15 (0;-0.12)	0.09 (-0.31;0.49)	0.11 (-0.31;0.54)	0.43 (-0.17;1.02)	0.07 (-0.26;1.04)	0.32 (-0.08;0.71)
SFA [%E]*	0.09 (-0.04;0.22)	0.06 (0;-0.08)	0.04 (-0.17;0.24)	0.11 (-0.12;0.33)	0.13 (-0.18;0.44)	0.01 (-0.17;1.04)	0.18 (-0.02;0.38)
MUFA [%E]*	0.02 (-0.09;0.12)	-0.01 (0;-0.12)	0 (-0.17;0.16)	-0.02 (-0.19;0.15)	0.11 (-0.12;0.34)	-0.07 (-0.2;1.04)	0.11 (-0.05;0.27)
PUFA[%E]*,[1]	0.02 (0;0.03)	0.02 (0;0)	0.01 (-0.01;0.04)	0.01 (-0.01;0.03)	0.03 (0;0.06)	0.03 (0.01;0.04)	0.01 (-0.02;0.03)
Cholesterol [mg]**,[1]	0 (-0.02;0.01)	0 (0;-0.02)	0 (-0.03;0.02)	-0.02 (-0.04;0.01)	0 (-0.03;0.04)	0.01 (-0.01;0.03)	-0.02 (-0.04;0.01)
CHO [E%]*	-0.19 (-0.5;0.11)	-0.26 (0;-0.59)	-0.05 (-0.54;0.44)	-0.21 (-0.71;0.29)	-0.35 (-1.04;0.34)	-0.07 (-0.47;1.03)	-0.34 (-0.8;0.13)
Sucrose [%E]*,[1]	0.01 (-0.01;0.03)	-0.01 (0;-0.03)	0.02 (-0.02;0.05)	0.01 (-0.03;0.04)	0 (-0.04;0.05)	0.01 (-0.02;0.04)	0.01 (-0.02;0.04)
Dietary fibres [g]**,[1]	0.06 (0.04;0.07)	0.05 (0;0.04)	0.04 (0.02;0.06)	0.06 (0.05;0.08)	0.05 (0.03;0.07)	0.05 (0.04;0.07)	0.06 (0.04;0.07)
Protein [%E]*,[1]	0 (-0.01;0.01)	0.01 (0;0)	0 (-0.01;0.01)	0.01 (0;0.03)	0 (-0.02;0.02)	0 (-0.01;0.01)	0.01 (-0.01;0.02)
Beta-Carotene [µg]**,[1]	0.17 (0.15;0.2)	0.18 (0;0.15)	0.17 (0.12;0.21)	0.2 (0.16;0.24)	0.13 (0.07;0.18)	0.18 (0.14;0.22)	0.17 (0.13;0.21)
Folate [µg]**,[1]	0.03 (0.02;0.04)	0.03 (0;0.01)	0.03 (0.01;0.05)	0.04 (0.02;0.06)	0.02 (0;0.05)	0.03 (0.02;0.05)	0.03 (0.02;0.05)
Calcium [mg]**,[1]	0.02 (0;0.03)	0.02 (0;0)	0.02 (0;0.04)	0.03 (0.01;0.05)	-0.01 (-0.04;0.02)	0.02 (0;0.04)	0.02 (0;0.04)
Iodine [µg]**,[1]	0.03 (0.02;0.04)	0.03 (0;0.02)	0.04 (0.02;0.06)	0.02 (0;0.05)	0.02 (-0.01;0.05)	0.04 (0.02;0.05)	0.02 (0;0.04)

*adjusted for, age, gender, BMI, and total fruit and vegetable intake **adjusted for total energy intake, age, gender, BMI, and fruit and vegetable intake
[1]date presented on the transformed scale (natural logarithm)

5. Discussion

The primary aim of the present study was to assess the diet quality with emphasize on dietary variety in 6 to 15-year-old schoolchildren. For this purpose, indexes of overall diet quality and dietary variety were generated. Those were compared with each other, and related to energy and nutrient intake. The following pages will discuss the most interesting and important results.

Diet quality at the nutrient level

Two indexes were generated in order to describe diet quality at the nutrient level: the deficient index (including data from 28 nutrients) and the excess index (including 5 nutrients). The deficient index was highly associated with energy intake, r_S=.73, p<.001. This result is in line with findings from the referenced literature (Foote *et al.*, 2004; Thiele *et al.*, 2004). As the probability of meeting the recommendations of nutrient intake increases the more a person eats, the result was as expected. The same was true for the excess index, r_S=-.69, p<.001; the more a person eats, the higher the probability of an excess intake of unfavourable nutrients. Therefore, it was as expected that the deficient index and the excess index were significantly negative related, r_S=-.56, p<.001. This means that children with a high deficient index (a desirable nutrient intake) had lower excess indexes (indicating an undesirable nutrient intake). Thiele and colleagues found the same association (Thiele *et al.*, 2004).

Diet quality at the food level

The Food Group Adequacy (FGA) was calculated in order to judge, whether the intake of food groups was appropriate. The approach used was similar to the approach of Cox and colleagues (Cox *et al.*, 1997) who generated the Variety Index for Toddlers (VIT) which was based on the U.S. Food Guide Pyramid. In contrast to FGA, which compares the amount in gram with the recommendation, VIT compares the number of "toddler sized" servings with the minimum recommended servings. A further difference is, that FGA subtracts points for excess intake of food groups that should not be consumed in high amounts, such as the tolerated foods (e.g. sweets and snacks), and foods that should be consumed moderately or rarely (e.g. fats and oils). In a study with 124 toddlers aged 24 to 36 months, VIT was strongly correlated with the mean adequacy ratio (MAR) on the basis of protein, calcium, zinc, magnesium, iron, vitamin A, vitamin B6, vitamin B12, vitamin C, vitamin B1, vitamin B2, and folate (r=.74, p<.01) (Cox *et al.*, 1997). This compares to the correlation of FGA and the deficient index, although this association was weaker (r_s .42, p<.001). The correlation of VIT with energy intake was higher (r=.54 to .66, at four collection periods) than of FGA (r_s=.16, p<.001), which might be due to the fact that FGA judges excess intake of certain foods negatively and VIT does not.

FGA was constructed to judge the adequacy of food consumption and not primarily to assess dietary variety. However, the Variety Index for Toddlers (VIT) was constructed similarly to FGA and according to Cox and colleagues VIT is an appropriate measure of variety among food groups (Cox *et al.*, 1997). Taking into consideration that only when consuming foods from all food groups (except for tolerated and rarely recommended foods), the highest FGA scores can be reached, it can be concluded, that FGA also includes the variety concept. Thus, FGA is not only a measure of an adequate food intake, but also of dietary variety. It furthermore becomes clear, that adequate food intake is only possible with a varied diet.

As FGA is based on optimiX and those guidelines were developed following nutrient based dietary guidelines, FGA was expected to be associated with nutrient adequacy. Regarding these assumption, the correlation coefficient of the deficient and excess index with FGA was - although statistically significant - quite weak (r_s .42, p<.001). As mentioned above, energy intake was neither included in the deficient nor in the excess index. The same is true for FGA; although optimiX takes into account energy requirements specifically for age groups and gender, energy was not included in the calculation of FGA as a separate variable. However, optimiX food intake recommendations were not only developed to meet nutrient, but also energy requirements. So FGA, in contrast to the deficient and excess indexes, indirectly takes into account energy intake. Thus, children meeting optimiX recommendations to a higher extent (high FGA) than others would also show a more adequate energy intake, which might explain the comparatively low correlation coefficient with energy compared to the measures of nutrient adequacy.

Regarding those results, it can be concluded that a diet following the optimiX recommendations is associated with nutrient adequacy without necessarily increasing energy intake.

Regarding results from regression analyses, decreased intake of sucrose at constant intake of carbohydrates indicates higher intake of complex carbohydrates and, therefore, desirable changes; increased PUFA intake at constant fat intake indicates better fat quality. Sodium intake in the Austrian population was identified as a nutrient with critically high intake, whereas dietary folate, vitamin D, and calcium were identified as nutrients with critically low intake. Additionally, intake of vitamin A, vitamin B1, B2, and B6, iodine, iron, and potassium were critical in school children (Elmadfa *et al.*, 2009a). Regarding micronutrient intake, increased intake levels are to be rated as a positive result except for sodium, which showed 18% higher intake in Q4 compared to Q1. It was shown, that intake of most critical nutrients was significantly higher for Q4 of FGA compared to Q1 (vitamin A, D, B1, and B6, folate, iron, potassium, and iodine). Of the critical nutrients, only vitamin B2 and calcium did not show an association with FGA. Taking into account presented results, FGA can be considered as a measure of diet quality in terms of nutrient adequacy.

Between-Group Variety (BGV1 and BGV2)

Several studies have shown improved nutrient intake with higher dietary variety (Randall *et al.*, 1985; Krebs-Smith *et al.*, 1987; Drewnowski *et al.*, 1997; Hatloy *et al.*, 1998; Arimond & Ruel, 2004; Falciglia *et al.*, 2004; Foote *et al.*, 2004; Thiele *et al.*, 2004; Murphy *et al.*, 2006; Steyn *et al.*, 2006) and dietary variety was also related to biochemical status (Royo-Bordonada *et al.*, 2003).

BGV1 and BGV2 showed very similar associations for most of the tested nutrients. Especially impact of dietary variety on energy and macronutrient intake were very much alike: Energy intake, fat, SFA, MUFA, PUFA, cholesterol, protein, and dietary fibres showed significantly higher intakes in Q4 of BGV1 and BGV2 compared to Q1, whereas intake of carbohydrates and sucrose (for BGV1) was significantly lower. Those results show that with higher BGV, macronutrient intake developed into an undesirable direction. However, increase in fat intake is also due to a higher PUFA intake, and decrease in carbohydrate intake for BGV1 is due to a great extent to a drop of 30% in sucrose intake.

Those results go together with findings by Drewnowski and colleagues (1996), who concluded that a diet including a variety of foods does not necessarily lead to a healthy diet in terms of low fat, SFA, or cholesterol intake.

Regarding the critical micronutrients in Austrian school children, intake of vitamin A, B2, B6, D, dietary folate, iron, potassium, calcium (BGV1), and iodine showed increased levels for Q4 compared to Q1. Only vitamin B1 and calcium (BGV2) did not increase from Q1 to Q4. As already seen for FGA, sodium intake was higher in Q4.

To sum up the presented results, BGV can be regarded as an indicator of diet quality in terms of nutrient adequacy, especially when regarding critical nutrients in the investigated population group. BGV1 showed more favourable changes compared to BGV2, when looking at the significantly decreased sucrose and increased calcium intake. Thus, minimum amounts that are specific for each food group as well as gender and age specific might be the better option compared to using minimum amounts that are the same for most of the food groups and unspecific with regard to gender and age.

The variety component of the HEI, for example, is determined with half a portion size as minimum amounts (Kennedy *et al.*, 1995). To construct the VIT, children's portion sizes were derived from the Food Guide Pyramid's portion sizes for adults (Cox *et al.*, 1997). Portion sizes are not always easy to determine. A portion of vegetables, for example, might be different depending on whether vegetables are consumed as a main course or side course. Compared to those approaches, using a percentage of the recommended intake is an easy way to construct age and gender-specific cut offs.

Fruit and Vegetable Variety (FVV)

To assess the association between Fruit and Vegetable Variety (FVV) and energy and nutrient intake was especially interesting, because of the various guidelines that include the recommendation to enjoy a variety of fruits and vegetables (USDA, 2005).

A diet that includes a variety of fruits and vegetables has already been shown to be associated with decreased cancer risk (Franceschi *et al.*, 1995; Jansen *et al.*, 2004). It was also related to lower body fatness (McCrory *et al.*, 1999) and improved nutrient intake (Foote *et al.*, 2004; Nowak, 2006).

In the present study, FVV was associated with higher intakes of energy and several nutrients. In contrast to BGV, FVV did not show negative effects on macronutrient intake. Fat intake as well as SFA, MUFA, and cholesterol intake were not significantly higher in Q4 compared to Q1, whereas PUFA were. High FVV was associated with a better fatty acid profile of the diets.

The critical nutrients, vitamin A, B2, B6, folate, potassium, calcium, iron, and iodine showed increased intake levels with higher FVV. But as already seen for BGV, FVV was also positively associated with sodium intake.

All regression models were adjusted for the consumed amount of fruits and vegetables. Therefore, it can be concluded, that FVV has positive effects on nutrient intake that exceed the effect of a high amount of fruits and vegetables. This conclusion has already been drawn by other authors and also applies to decreased cancer risk (Nowak, 2006); (Franceschi *et al.*, 1995; Jansen *et al.*, 2004).

At this point it has to be pointed out, that intake of nutrients not provided in high amounts by fruits and vegetables (e.g. vitamin D) was also higher in higher quarters of FFV. This might seem a bit inconclusive at first, but a plausible explanation is that persons consuming a diet including a high variety of fruits and vegetables might have a healthier dietary pattern regarding all foods from all food groups than persons consuming fewer different fruits and vegetables.

Studies have not only shown better nutrient adequacy, but also a positive influence of FFV on health outcomes such as decreased risk of cancer. This is not to be reduced to increased nutrient adequacy, but to other components of fruits and vegetables such as phytochemicals. Considering that diets that include a variety of fruits and vegetables might also be associated with an in total healthier food choice, this fact might also play a role in the cancer preventive effect that has already been shown for FVV.

Thus, to choose a variety of fruits and vegetables daily, can be considered as an appropriate recommendation in order to promote a high quality diet, not only in terms of nutrient adequacy, but also in terms of reduction of NCD.

Comparison of FGA, BGV, and FVV and discussion of their ability to describe overall dietary quality

Although initially FGA was not considered to be a measure of dietary variety, it will also be discussed with BGV and FVV. As mentioned above, FGA indirectly also includes variety, as the maximum score can only be reached, when consuming foods out of each food group, except for tolerated and sparingly recommended foods.

Because of the alarmingly high prevalence of overweight and obesity (Elmadfa *et al.*, 2009b), special attention has to be paid to energy intake when judging the quality of a diet. FGA was the only score that was not significantly associated with energy intake. The association between FFV and energy was weaker than for BGV1 and BGV2.

Regarding macronutrient intake, FGA and FFV showed more favourable results than BGV1 and BGV2, whereas impact on micronutrient intake on the whole was comparable. Biggest differences were shown for vitamin D, B12, and iodine for which BGV1 and BGV2 showed notably higher increases from Q1 to Q4 than FGA and FVV. Vitamin B1 was the only nutrient which was not significantly associated with any of the scores.

All four indexes were significantly correlated with energy intake. This goes in line with several other studies (McCrory *et al.*, 1999; Marshall *et al.*, 2001; Royo-Bordonada *et al.*, 2003; Foote *et al.*, 2004). McCrory and colleagues showed that variety within the food group of breakfast foods, lunch and dinner entrées, sweets, snacks, and carbohydrates, and condiments were positively associated with body fatness, whereas variety within the vegetable group showed a negative association. They concluded that the supply of an increasing variety of food may thus be a reason for the increasing prevalence of obesity (McCrory *et al.*, 1999).

However, a study with a dietary diversity score based on 5 food groups (dairy, meat, grain, fruits, vegetables), showed an inverse association of DDS and energy intake (Drewnowski *et al.*, 1996), which again highlights the importance of a clear definition of dietary variety.

Dietary variety as part of food-based dietary guidelines (FBDG)

To choose a variety of foods is part of several FBDG throughout the world (Elmadfa *et al.*, 2003; USDA, 2005). This recommendation is seldom explained further, for example, if a variety should be consumed within or between food groups. This can lead to misunderstanding and as dietary variety may be positively associated with energy intake, can also lead to overweight and obesity (McCrory *et al.*, 1999). Therefore, when promoting a varied diet, the need to stay within an adequate range of energy intake has to be stressed (Foote *et al.*, 2004).

With this in mind, the term “variety” should be accompanied by further explications, which is especially difficult as many different concepts and definitions are being used. On the other hand, FBDG should be easy to understand and feasible, so it would not make a lot of sense to recommend a varied diet following the concept of BGV1; people would need to know the gender- and age-specific recommended amounts, and to divide them by four to get the minimum amount, they should consume per food group per day, as this is the way, BGV1 was constructed. In this sense, BGV2, with a general minimum amount of 20 g per food group (except for the food group of fats and oils) might be easier to follow. As both variety concepts were linked to very similar associations with energy and nutrient intake, such a recommendation would be acceptable.

In the WHO/FAO Report on Diet, Physical Activity and the Prevention of Cancer, it is mentioned that 20-30 “biological distinct foods” per week would provide the required nutrients (WHO & FAO, 2003). Savige and colleagues (1997) judged more than 30 different foods per week as “very good”. They provided a checklist in their publication, which is also available from the internet (Nutrition Australia, 2010a). The question of how many different foods should be consumed per day was not addressed in the present study because of methodological reasons: food grouping was done at the ingredient level and not at the recipe level. Dietary variety scores, which count foods or food groups at the individual level, in most cases lead to higher results compared to scores at the recipe level. As consumers eat dishes and not single nutrients, the question on how many different foods are recommendable should be answered at the recipe level. Another point is the reference period. Dietary variety scores change over time (Drewnowski *et al.*, 1997; Falciglia *et al.*, 2004). Drewnowski and colleagues found that for one day the mean dietary variety was 13, for three days 26, and for 15 days 64 (Drewnowski *et al.*, 1997). Therefore, it is not valid to simply divide a dietary variety score by the number of assessment days. On the other hand, a recommendation given for a time period of three days, as used in our study, might not be feasible for the consumers.

Regarding above mentioned considerations to identify the number of different foods or food groups that should be consumed during a given time period, and to develop dietary variety recommendations and especially to test their feasibility remain future tasks.

6. Conclusions

The developed food based indexes FGA, BGV1, BGV2, and FVV can be used to describe diet quality in terms of an adequate nutrient intake.

Food Group Adequacy (FGA) is not only an adequate measure of overall diet quality at the food level but also a measure of dietary variety. Dietary variety, measured with two different sets of minimum amounts (BGV1 and BGV2), is positively associated with indexes of overall diet quality (deficient index, FGA) in Austrian school children. Although different minimum amounts were applied when generating BGV1 and BGV2, associations with energy and nutrient intake are similar for both indexes.

Fruit and Vegetable Variety (FVV) has positive effects on nutrient intake that go beyond the effects of consumed fruit and vegetable amount. Although FVV only looks at two food groups, associations with energy and nutrient intake compare to FGA, BGV1, and BGV2.

Giving the recommendation of following a diet that includes foods from each of the 10 optimiX food groups (except for tolerated foods) might be an easy way to increase children´s nutrient adequacy. Adding the recommendation of consuming a variety of fruits and vegetables might further improve children´s diets.

FGA shows the most favorable associations with nutrient intake compared to all other studied food based indexes. However, also BGV1, BGV2, and FVV are indicators for an adequate nutrient intake. It may depend on the scope of the study which index to use.

7. Abstract

With regard to the increasing prevalences of diet-related chronic diseases, nutrition monitoring plays a crucial role in disease prevention. For this purpose, many indexes of overall diet quality have been proposed, among them also measures of dietary variety. The primary aim of present study was to evaluate diet quality and dietary variety in Austrian schoolchildren, and to compare different measures of diet quality.

In a cross-sectional survey of 780 children aged six to 15 years (mean: 10.6 years, SD: 2.1) dietary intake was measured using three day dietary records. Four food based indexes were developed: (1) the Food Group Adequacy (FGA), which compares food intake with the respective recommendation; (2) Between-Group Variety 1 (BGV1), which counts all consumed food groups that are consumed in an amount of at least 25% of the recommended amount; (3) Between-Group Variety 2 (BGV2), which is similar to BGV1 but applies a minimum amount of 10 g/d for fats and oils and 20 g/d for each other food group; (4) Fruit and Vegetable Variety (FVV), a count of all different fruits and vegetables consumed over three days, using a minimum amount of 20 g/d.

In multiple linear regression models, associations between FGA, BGV1, BGV2, and FVV and intake of energy and 33 nutrients were tested, adjusting for total energy intake (where appropriate), total amount of foods and beverage intake or fruit and vegetable intake, respectively, sex, body mass index, and age. Data were categorised into quarters according to quartiles of the indexes.

All four indexes were positively associated with diet quality in terms of adequate nutrient intake. FGA was the only score, not associated with higher energy intake. BGV1 and BGV2 were in contrast to FGA and FVV associated with higher intake of total fat, SFA, and MUFA. All scores were associated with higher PUFA and dietary fibre intake and all scores but FVV were associated with lower intake of carbohydrates and sucrose and higher intake of protein. Intake of most tested vitamins and minerals showed higher intakes with all scores.

In conclusion, FGA showed the most favourable associations with energy and nutrient intake, especially regarding intake of energy and macronutrients. However, also BGV1, BGV2, and FVV are indicators for an adequate nutrient intake. It may depend on the scope of the study which index to use.

8. Zusammenfassung

In Zusammenhang mit den steigenden Prävalenzen von ernährungsassoziierten chronischen Erkrankungen kommt dem Ernährungsmonitoring eine besonders wichtige Rolle zu. Zu diesem Zweck wurden verschiedene Indizes zur Beschreibung der Ernährungsqualität vorgeschlagen, so auch Indizes zur Beschreibung der Lebensmittelvielfalt. Primäres Ziel vorliegender Studie war die Erfassung der Lebensmittequalität und Lebensmittelvielfalt von österreichischen Schulkindern und der Vergleich verschiedener Ernährungsqualitätsindizes.

In einer Querschnittsstudie wurden 3-Tages-Ernährungsprotokolle von 780 Kindern im Alter zwischen sechs und fünfzehn (Mittelwert: 10,6 Jahre, SD: 2.1) Jahren erhoben. Vier verschiedene Indizes wurden berechnet: (1) die *Food Group Adequacy* (FGA), die die Aufnahme einer Lebensmittelgruppe mit der entsprechenden Ernährungsempfehlung vergleicht; (2) die Lebensmittelgruppenvielfalt 1 (BGV1), die alle konsumierten Lebensmittelgruppen zählt, die in einer Menge von mindestens 25% der empfohlenen Menge verzehrt wurden; (3) die Lebensmittelgruppenvielfalt 2 (BGV2), die ähnlich BGV1 ist aber eine Mindestmenge von 10 g/d für Fette und Öle und 20 g/d für alle anderen Lebensmittelgruppen ansetzt; (4) die Obst- und Gemüsevielfalt (FFV), die alle verschiedenen Obst- und Gemüsesorten zählt, die innerhalb von drei Tagen konsumiert wurden, mit einer Mindestmenge von 20 g/d.

In multiplen linearen Regression wurden die Zusammenhänge zwischen FGA, BGV1, BGV2 und FVV getestet. Die Modelle wurden für Gesamtenergieaufnahme (wo angebracht), gesamte Lebensmittelaufnahme bzw. Obst und Gemüseaufnahme, Geschlecht, Body Mass Index und Alter adjustiert. Die Daten wurden anhand der Quartile der Indizes kategorisiert.

Alle vier Indizes zeigten einen positiven Zusammenhang mit der Ernährungsqualität im Sinne einer adäquaten Nährstoffaufnahme. FGA war der einzige Score, der nicht mit einer höheren Energieaufnahme assoziiert war. BGV1 und BGV2 waren im Gegensatz zu FGA und FVV mit einer höheren Aufnahme von Gesamtfett, gesättigten und einfach ungesättigten Fettsäuren assoziiert. Alle Indizes hingen positiv mit einer höheren Aufnahme von mehrfach ungesättigten Fettsäuren und Ballaststoffen zusammen und alle Indizes mit Ausnahme von FVV zeigten einen negativen Zusammenhang mit der Aufnahme von Kohlenhydraten und Zucker und einen positiven mit Protein. Die Aufnahme der meisten Vitamine und Mineralstoffe war positiv mit allen Indizes assoziiert.

FGA zeigte im Vergleich mit den anderen untersuchten lebensmittelbasierten Indizes die wünschenswertesten Zusammenhänge mit der Energie- und Nährstoffaufnahme. Dennoch sind auch BGV1, BGV2 und FVV Indikatoren für eine adäquate Nährstoffaufnahme. Die Auswahl des zu verwendenden Indexes hängt von der Zielsetzung der jeweiligen Studie ab.

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Annexes

Annex 1: Supplementing Tables

Annex 2: Food Record

Annex 3: Publications with Author´s Contributions

Annex 1: Supplementing Tables

Table 31 Geometric means (95% CI)) of daily energy and nutrient intakes by Food Group Adequacy (FGA) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake

FGA	Quarter 1 (low diet quality)	Quarter 2	Quarter 3	Quarter 4 (high diet quality)	Adusted R^2	p for trend
n (%) total=780	195 (25)	195 (25)	195 (25)	195 (25)		
Energy [MJ][1]	6.66 (6.44;6.88)	6.5 (6.29;6.71)	6.65 (6.44;6.87)	6.44 (6.23;6.67)	.44	.296
Fat [%E][2]	34.5 (33.5;35.4)	34.6 (33.6;35.5)	34.6 (33.7;35.6)	35.3 (34.3;36.3)	.07	.215
SFA [%E][2]	14.4 (13.9;14.9)	14.5 (14;15)	14.6 (14.1;15.1)	14.8 (14.3;15.4)	.03	.186
MUFA [%E][2]	12.1 (11.8;12.5)	12.1 (11.7;12.5)	11.9 (11.6;12.3)	12.1 (11.7;12.5)	.07	.773
PUFA[%E][1]	5.5 (5.3;5.8)	5.8 (5.5;6.1)	6 (5.7;6.3)	6.1 (5.8;6.5)	.03	.002
Cholesterol [mg]	199 (188;210)	212 (201;223)	221 (209;233)	231 (218;244)	.41	<.001
CHO [E%][2]	50.9 (49.8;52)	51.1 (50;52.2)	50.4 (49.3;51.5)	49.5 (48.3;50.7)	.11	.045
Sucrose [%E][1]	16.8 (15.6;18.1)	15.7 (14.6;16.9)	14.4 (13.4;15.5)	12.7 (11.8;13.7)	.11	<.001
Dietary fibres [g]	11 (11;12)	13 (13;14)	14 (14;15)	16 (15;16)	.54	<.001
Protein [%E][1]	14.2 (13.7;14.6)	14 (13.6;14.5)	14.6 (14.2;15.1)	14.9 (14.5;15.4)	.09	.003
Vitamin A [µg][a]	0.49 (0.45;0.53)	0.58 (0.53;0.63)	0.65 (0.59;0.7)	0.72 (0.66;0.79)	.28	<.001
Beta-Carotene [µg][b]	0.89 (0.79;1)	1.15 (1.03;1.29)	1.34 (1.2;1.5)	1.6 (1.42;1.81)	.23	<.001
Vitamin D [µg]	1 (0.91;1.1)	1.19 (1.08;1.31)	1.23 (1.12;1.35)	1.34 (1.21;1.48)	.22	<.001
Vitamin E [mg][c]	8.22 (7.77;8.69)	9.38 (8.88;9.9)	10 (9.47;10.55)	10.49 (9.91;11.11)	.35	<.001
Vitamin B1 [mg]	0.82 (0.79;0.86)	0.85 (0.81;0.88)	0.81 (0.78;0.85)	0.87 (0.83;0.91)	.47	.206
Vitamin B2 [mg]	1.02 (0.97;1.06)	1.09 (1.04;1.14)	1.13 (1.08;1.18)	1.15 (1.09;1.2)	.46	<.001
Niacin [mg][d]	17.1 (16.5;17.8)	17.2 (16.6;17.9)	18 (17.4;18.7)	18.3 (17.6;19)	.53	.002
Panthotenic acid [mg]	2.94 (2.81;3.08)	3.19 (3.06;3.33)	3.39 (3.24;3.54)	3.52 (3.36;3.69)	.48	<.001
Vitamin B6 [mg]	0.96 (0.91;1.01)	0.99 (0.95;1.04)	1.04 (0.99;1.09)	1.1 (1.04;1.15)	.41	<.001
Biotin [mg]	25.8 (24.7;26.9)	29.2 (28;30.5)	30.2 (29;31.6)	31.7 (30.3;33.1)	.50	<.001
Folate [µg][e]	122 (116;128)	140 (134;146)	145 (138;151)	160 (152;167)	.47	<.001
Vitamin B12 [µg]	2.99 (2.8;3.19)	3.16 (2.97;3.37)	3.25 (3.05;3.46)	3.48 (3.26;3.72)	.31	<.001
Vitamin C [mg]	78.6 (70.8;87.2)	86.6 (78.2;95.9)	90.1 (81.4;99.8)	101.5 (91.2;113)	.18	<.001
Sodium [mg]	2293 (2204;2386)	2448 (2355;2544)	2657 (2557;2762)	2804 (2692;2921)	.43	<.001
Chloride [mg]	3656 (3518;3799)	3900 (3757;4048)	4235 (4080;4395)	4505 (4331;4686)	.45	<.001
Potassium [mg]	1490 (1439;1544)	1631 (1576;1688)	1781 (1721;1843)	1917 (1849;1987)	.59	<.001
Calcium [mg]	573 (545;603)	628 (598;660)	665 (633;699)	676 (641;712)	.46	<.001
Phosphorus [mg]	813 (788;838)	862 (837;889)	912 (885;940)	951 (922;982)	.65	<.001
Magnesium [mg]	190 (184;195)	207 (201;213)	219 (212;225)	228 (221;236)	.65	<.001
Iron [mg]	7.87 (7.63;8.11)	8.23 (7.99;8.48)	8.43 (8.19;8.68)	8.71 (8.45;8.99)	.64	<.001
Iodine [µg]	112 (107;117)	117 (112;122)	135 (129;141)	140 (134;146)	.42	<.001
Zinc [mg]	6.98 (6.78;7.19)	7.46 (7.24;7.67)	7.77 (7.55;8)	8.04 (7.8;8.29)	.65	<.001
Copper [mg]	1.24 (1.21;1.27)	1.34 (1.3;1.37)	1.38 (1.34;1.42)	1.44 (1.4;1.48)	.72	<.001
Manganese [mg]	2.32 (2.19;2.44)	2.71 (2.57;2.85)	2.83 (2.68;2.98)	3.12 (2.95;3.3)	.38	<.001

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]percent of change from quarter 1 to 4; [2]adjusted for age, gender, BMI, and total food and beverage intake; [3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 32 Geometric means (95% CI) of daily energy and nutrient intakes by Between-Group Variety 1 (BGV1) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adusted R^2	p for trend
n (%) total=741	224 (30.2)	224 (30.2)	200 (27.0)	93 (12.6)		
Energy [MJ][1]	6.11 (5.92;6.3)	6.66 (6.46;6.86)	6.99 (6.77;7.22)	6.92 (6.62;7.24)	.47	<.001
Fat [%E][2]	32.9 (32;33.8)	34.5 (33.7;35.4)	35.7 (34.8;36.6)	37 (35.7;38.2)	.11	<.001
SFA [%E][2]	13.9 (13.5;14.4)	14.5 (14.1;15)	14.9 (14.5;15.4)	15.7 (15;16.3)	.06	<.001
MUFA [%E][2]	11.5 (11.2;11.9)	12 (11.6;12.3)	12.4 (12.1;12.8)	12.6 (12.1;13.1)	.10	<.001
PUFA[%E][1]	5.3 (5;5.5)	5.9 (5.6;6.1)	6.2 (5.9;6.5)	6.4 (6;6.9)	.07	<.001
Cholesterol [mg]	192 (183;202)	213 (203;224)	221 (209;233)	283 (263;304)	.46	<.001
CHO [E%][2]	53 (51.9;54)	51 (50;52)	49.2 (48.1;50.3)	47.1 (45.6;48.5)	.17	<.001
Sucrose [%E][1]	17.3 (16.1;18.6)	14.9 (14;16)	14.4 (13.4;15.5)	13.4 (12.1;14.8)	.10	<.001
Dietary fibres [g]	12 (11;12)	14 (13;14)	14 (14;15)	15 (14;16)	.46	<.001
Protein [%E][1]	13.7 (13.3;14.2)	14.1 (13.7;14.5)	14.8 (14.3;15.2)	15.8 (15.2;16.5)	.12	<.001
Vitamin A [µg][a]	0.5 (0.46;0.55)	0.6 (0.55;0.64)	0.7 (0.65;0.77)	0.76 (0.67;0.85)	.28	<.001
Beta-Carotene [µg][b]	0.86 (0.77;0.96)	1.16 (1.04;1.29)	1.62 (1.44;1.81)	1.7 (1.46;1.99)	.26	<.001
Vitamin D [µg]	1.01 (0.93;1.1)	1.17 (1.08;1.27)	1.23 (1.13;1.35)	1.95 (1.73;2.2)	.28	<.001
Vitamin E [mg][c]	8.25 (7.83;8.69)	9.52 (9.06;10.01)	10.32 (9.78;10.9)	11.06 (10.27;11.91)	.36	<.001
Vitamin B1 [mg]	0.82 (0.78;0.85)	0.85 (0.81;0.88)	0.84 (0.8;0.88)	0.84 (0.79;0.89)	.47	.518
Vitamin B2 [mg]	1.07 (1.02;1.12)	1.07 (1.03;1.12)	1.12 (1.07;1.18)	1.18 (1.11;1.26)	.45	.004
Niacin [mg][d]	16.7 (16.1;17.3)	17.2 (16.6;17.8)	18.4 (17.7;19.1)	19.1 (18.2;20.1)	.54	<.001
Panthotenic acid [mg]	3.06 (2.92;3.19)	3.19 (3.05;3.33)	3.4 (3.25;3.56)	3.68 (3.46;3.92)	.46	<.001
Vitamin B6 [mg]	0.95 (0.9;0.99)	1.01 (0.97;1.06)	1.06 (1.01;1.12)	1.09 (1.01;1.16)	.40	<.001
Biotin [mg]	27.4 (26.2;28.6)	28.5 (27.3;29.7)	29.9 (28.6;31.3)	34.4 (32.3;36.5)	.48	<.001
Folate [µg][e]	125 (119;130)	142 (136;148)	148 (141;155)	164 (153;174)	.44	<.001
Vitamin B12 [µg]	2.88 (2.71;3.06)	3.1 (2.93;3.29)	3.5 (3.28;3.72)	4.16 (3.82;4.53)	.35	<.001
Vitamin C [mg]	72.5 (65.6;80.1)	90.1 (81.8;99.2)	96.4 (86.8;107)	107.2 (93;123.6)	.19	<.001
Sodium [mg]	2263 (2180;2350)	2575 (2484;2669)	2679 (2577;2785)	2838 (2692;2993)	.44	<.001
Chloride [mg]	3611 (3483;3743)	4115 (3975;4260)	4295 (4137;4459)	4520 (4295;4757)	.46	<.001
Potassium [mg]	1544 (1490;1599)	1677 (1621;1735)	1783 (1718;1849)	1904 (1811;2002)	.55	<.001
Calcium [mg]	618 (589;649)	636 (607;666)	640 (608;673)	704 (657;755)	.44	.002
Phosphorus [mg]	832 (808;857)	875 (851;901)	906 (878;934)	999 (958;1043)	.64	<.001
Magnesium [mg]	199 (193;205)	210 (204;216)	217 (210;224)	223 (214;233)	.62	<.001
Iron [mg]	7.88 (7.65;8.11)	8.3 (8.07;8.54)	8.61 (8.35;8.88)	8.66 (8.3;9.03)	.64	<.001
Iodine [µg]	106 (102;110)	122 (117;127)	140 (135;146)	160 (151;169)	.49	<.001
Zinc [mg]	7.02 (6.83;7.23)	7.54 (7.34;7.75)	7.91 (7.68;8.14)	8.14 (7.82;8.47)	.65	<.001
Copper [mg]	1.28 (1.25;1.32)	1.35 (1.32;1.39)	1.39 (1.35;1.43)	1.39 (1.33;1.44)	.69	.001
Manganese [mg]	2.53 (2.4;2.67)	2.78 (2.64;2.93)	2.82 (2.66;2.98)	2.88 (2.66;3.1)	.32	.006

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]percent of change from quarter 1 to 4; [2]adjusted for age, gender, BMI, and total food and beverage intake; [3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 33 Geometric means (95% CI) of daily energy and nutrient intakes by Between-Group Variety 2 (BGV2) categories, adjusted for age, gender, BMI, energy, and total food and beverage intake

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adusted R^2	p for trend
n (%) total=741	190 (25.6)	303 (40.9)	205 (27.7)	43 (5.8)		
Energy [MJ][1]	5.95 (5.76;6.14)	6.68 (6.51;6.86)	7.02 (6.81;7.24)	6.92 (6.51;7.35)	.49	<.001
Fat [%E][2]	32.7 (31.8;33.6)	34.4 (33.6;35.1)	36.1 (35.2;37)	37.1 (35.4;38.9)	.12	<.001
SFA [%E][2]	13.8 (13.3;14.3)	14.4 (14;14.9)	15.2 (14.8;15.7)	15.6 (14.7;16.5)	.06	<.001
MUFA [%E][2]	11.5 (11.1;11.9)	12 (11.7;12.3)	12.5 (12.2;12.9)	12.4 (11.7;13.1)	.10	.008
PUFA[%E][1]	5.2 (5;5.5)	5.8 (5.6;6.1)	6.1 (5.8;6.4)	6.9 (6.3;7.6)	.07	<.001
Cholesterol [mg]	178 (170;188)	201 (193;210)	265 (253;279)	300 (273;329)	.54	<.001
CHO [E%][2]	53.1 (52;54.2)	51.2 (50.3;52)	48.6 (47.5;49.6)	47.2 (45.1;49.2)	.17	<.001
Sucrose [%E][1]	16.1 (15;17.4)	15.3 (14.4;16.3)	14.5 (13.5;15.6)	14.8 (12.9;17)	.08	.195
Dietary fibres [g]	12 (12;13)	14 (13;14)	13 (13;14)	14 (13;15)	.43	.016
Protein [%E][1]	13.8 (13.4;14.3)	14.1 (13.7;14.5)	14.9 (14.5;15.4)	15.6 (14.7;16.5)	.10	<.001
Vitamin A [µg][a]	0.51 (0.46;0.55)	0.61 (0.56;0.65)	0.7 (0.65;0.76)	0.7 (0.6;0.83)	.27	<.001
Beta-Carotene [µg][b]	0.85 (0.76;0.96)	1.3 (1.18;1.43)	1.45 (1.29;1.62)	1.43 (1.15;1.77)	.23	<.001
Vitamin D [µg]	0.86 (0.79;0.93)	1.09 (1.02;1.17)	1.65 (1.53;1.79)	2.38 (2.05;2.78)	.40	<.001
Vitamin E [mg][c]	8.2 (7.76;8.66)	9.61 (9.19;10.05)	10.02 (9.5;10.57)	11.89 (10.73;13.17)	.36	<.001
Vitamin B1 [mg]	0.82 (0.78;0.85)	0.85 (0.82;0.89)	0.82 (0.78;0.85)	0.85 (0.78;0.92)	.47	.626
Vitamin B2 [mg]	1.04 (0.99;1.1)	1.12 (1.07;1.16)	1.1 (1.05;1.15)	1.17 (1.07;1.28)	.45	.043
Niacin [mg][d]	16.5 (15.9;17.1)	17.6 (17.1;18.1)	18.1 (17.5;18.8)	19.4 (18.1;20.8)	.54	<.001
Panthotenic acid [mg]	2.99 (2.86;3.14)	3.3 (3.18;3.43)	3.36 (3.21;3.51)	3.63 (3.33;3.96)	.46	<.001
Vitamin B6 [mg]	0.94 (0.89;0.99)	1.04 (1;1.08)	1.02 (0.97;1.07)	1.12 (1.02;1.23)	.40	.001
Biotin [mg]	26.1 (24.9;27.3)	29.2 (28.2;30.3)	31.1 (29.8;32.5)	34.2 (31.5;37.2)	.49	<.001
Folate [µg][e]	125 (119;131)	145 (140;151)	145 (138;152)	157 (143;171)	.43	<.001
Vitamin B12 [µg]	2.75 (2.58;2.92)	3.12 (2.97;3.28)	3.73 (3.51;3.96)	4.42 (3.94;4.96)	.38	<.001
Vitamin C [mg]	71.1 (63.9;79.1)	92.3 (84.7;100.7)	96.3 (86.9;106.7)	95.6 (78.5;116.3)	.19	.006
Sodium [mg]	2361 (2267;2459)	2546 (2463;2632)	2631 (2530;2737)	2694 (2499;2905)	.41	.001
Chloride [mg]	3757 (3612;3907)	4081 (3952;4213)	4188 (4032;4350)	4354 (4049;4682)	.42	<.001
Potassium [mg]	1535 (1478;1594)	1725 (1673;1779)	1745 (1683;1810)	1833 (1709;1966)	.54	<.001
Calcium [mg]	618 (587;651)	652 (625;680)	636 (605;668)	660 (600;726)	.44	.306
Phosphorus [mg]	836 (809;863)	888 (865;912)	909 (881;937)	947 (892;1005)	.63	<.001
Magnesium [mg]	202 (196;209)	213 (208;219)	210 (203;217)	218 (205;232)	.61	.040
Iron [mg]	7.81 (7.57;8.06)	8.43 (8.22;8.64)	8.49 (8.24;8.75)	8.5 (8.02;9)	.64	.009
Iodine [µg]	106 (102;111)	121 (117;126)	142 (136;148)	169 (156;183)	.48	<.001
Zinc [mg]	7.14 (6.92;7.36)	7.6 (7.41;7.79)	7.77 (7.54;8)	7.81 (7.38;8.27)	.63	.003
Copper [mg]	1.3 (1.26;1.33)	1.37 (1.33;1.4)	1.35 (1.32;1.39)	1.37 (1.29;1.45)	.69	.109
Manganese [mg]	2.6 (2.45;2.75)	2.8 (2.67;2.94)	2.69 (2.54;2.84)	2.83 (2.54;3.14)	.31	.242

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]percent of change from quarter 1 to 4; [2]adjusted for age, gender, BMI, and total food and beverage intake; [3]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 34 Geometric means (95% CI) of daily energy and nutrient intakes by Fruit and Vegetable Variety (FVV) categories, adjusted for age, gender, BMI, energy, and fruit and vegetable intake

	Quarter 1 (low variety)	Quarter 2	Quarter 3	Quarter 4 (high variety)	Adusted R^2	p for trend
n (%) total=721	231 (31.2)	162 (21.9)	222 (30.0)	106 (14.3)		
Energy [MJ][1]	6.61 (6.36;6.87)	6.67 (6.38;6.97)	6.93 (6.66;7.2)	7.18 (6.81;7.57)	.16	.006
Fat [%E][2]	34.5 (33.6;35.4)	33.6 (32.6;34.7)	34.3 (33.4;35.2)	35.4 (34.1;36.6)	.06	.163
SFA [%E][2]	14.3 (13.9;14.8)	14.2 (13.7;14.8)	14.8 (14.3;15.3)	14.8 (14.1;15.4)	.05	.139
MUFA [%E][2]	12.1 (11.7;12.4)	11.7 (11.3;12.1)	11.9 (11.5;12.3)	12 (11.5;12.5)	.08	.995
PUFA[%E][1]	5.8 (5.5;6.1)	5.6 (5.3;5.9)	5.5 (5.2;5.8)	6.4 (6;6.8)	.02	.032
Cholesterol [mg]	217 (205;229)	214 (201;227)	209 (198;221)	212 (197;228)	.39	.545
CHO [E%][2]	50.6 (49.5;51.7)	51.8 (50.6;53)	51.5 (50.4;52.6)	49.8 (48.3;51.3)	.08	.350
Sucrose [%E][1]	14.8 (13.7;15.8)	15.8 (14.6;17.1)	16.7 (15.5;17.9)	15.7 (14.2;17.3)	.02	.226
Dietary fibres [g]	12 (12;13)	13 (13;14)	14 (14;15)	16 (15;17)	.47	<.001
Protein [%E][1]	14.5 (14;14.9)	14.2 (13.7;14.7)	13.9 (13.4;14.3)	14.6 (14;15.2)	.05	.932
Vitamin A [µg][a]	0.51 (0.47;0.55)	0.61 (0.56;0.67)	0.68 (0.63;0.74)	0.84 (0.75;0.93)	.31	<.001
Beta-Carotene [µg][b]	0.87 (0.79;0.96)	1.19 (1.07;1.33)	1.61 (1.46;1.78)	2.24 (1.96;2.56)	.38	<.001
Vitamin D [µg]	1.21 (1.11;1.33)	1.13 (1.02;1.24)	1.2 (1.1;1.32)	1.23 (1.09;1.39)	.20	.661
Vitamin E [mg][c]	9.18 (8.72;9.67)	9.33 (8.8;9.89)	9.46 (8.97;9.97)	10.95 (10.2;11.76)	.35	<.001
Vitamin B1 [mg]	0.86 (0.82;0.89)	0.83 (0.79;0.87)	0.82 (0.79;0.85)	0.85 (0.8;0.9)	.47	.655
Vitamin B2 [mg]	1.09 (1.04;1.14)	1.1 (1.05;1.16)	1.1 (1.05;1.15)	1.18 (1.11;1.25)	.45	.052
Niacin [mg][d]	17.5 (16.9;18.1)	17.5 (16.8;18.2)	17.4 (16.7;18)	18.8 (17.9;19.8)	.53	.032
Panthothenic acid [mg]	3.15 (3.02;3.28)	3.31 (3.16;3.47)	3.32 (3.18;3.46)	3.68 (3.47;3.89)	.51	<.001
Vitamin B6 [mg]	0.97 (0.93;1.01)	1.02 (0.97;1.07)	1.05 (1;1.1)	1.18 (1.11;1.26)	.48	<.001
Biotin [mg]	28.6 (27.4;29.7)	29 (27.7;30.3)	30.3 (29.1;31.6)	32.3 (30.5;34.1)	.52	<.001
Folate [µg][e]	134 (129;140)	139 (133;145)	153 (146;159)	158 (149;167)	.50	<.001
Vitamin B12 [µg]	3.32 (3.12;3.53)	3.25 (3.03;3.48)	3.1 (2.91;3.3)	3.27 (3;3.56)	.30	.555
Vitamin C [mg]	79.2 (73.1;85.9)	94.7 (86.4;103.7)	103.3 (95;112.2)	116.9 (104.5;130.8)	.39	<.001
Sodium [mg]	2425 (2335;2519)	2516 (2410;2626)	2588 (2489;2691)	2643 (2507;2786)	.40	.005
Chloride [mg]	3861 (3722;4005)	4014 (3851;4184)	4155 (4001;4314)	4281 (4068;4505)	.41	.001
Potassium [mg]	1627 (1584;1672)	1709 (1657;1762)	1794 (1745;1845)	1914 (1843;1987)	.71	<.001
Calcium [mg]	623 (594;653)	650 (616;686)	659 (627;692)	681 (637;728)	.43	.027
Phosphorus [mg]	880 (854;907)	867 (838;897)	889 (862;917)	933 (895;973)	.62	.014
Magnesium [mg]	205 (199;211)	210 (203;216)	218 (211;224)	228 (219;237)	.65	<.001
Iron [mg]	8.14 (7.91;8.37)	8.46 (8.2;8.74)	8.4 (8.16;8.64)	8.88 (8.54;9.23)	.65	.001
Iodine [µg]	118 (113;124)	127 (120;133)	131 (125;137)	135 (127;144)	.27	<.001
Zinc [mg]	7.4 (7.19;7.62)	7.46 (7.22;7.71)	7.55 (7.33;7.77)	8.09 (7.77;8.41)	.63	<.001
Copper [mg]	1.31 (1.27;1.35)	1.36 (1.32;1.41)	1.39 (1.35;1.43)	1.42 (1.37;1.49)	.63	.001
Manganese [mg]	2.58 (2.45;2.72)	2.65 (2.5;2.82)	2.88 (2.72;3.04)	3.04 (2.82;3.27)	.31	<.001

SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]percent of change from quarter 1 to 4; [2]adjusted for age, gender, BMI, and total food and beverage intake; [3]arithmetic mean, adjusted for gender, age, BMI, fruit and vegetable intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 35 Sensitivity analyses for Food Group Adequacy (FGA) applying different cut-offs for mis-reporting (under- and over-reporting) and gender: β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Mis-reporter cut-off 1	Mis-reporter cut-off 2
n	780	540
Energy [MJ]*, [2]	-0.11 (-0.25;0.04)	-0.25 (-0.39;-0.12)
Fat [%E]**, [3]	14.75 (-28.19;57.69)	-22.95 (-72.41;26.52)
SFA [%E]**, [3]	11.34 (-11.56;34.24)	-8.93 (-35.17;17.31)
MUFA [%E]**, [3]	-10.16 (-27.75;7.43)	-20.99 (-41.36;-0.63)
PUFA[%E]*, [2]	0.35 (0.12;0.59)	0.21 (-0.07;0.49)
Cholesterol [mg]*	0.52 (0.27;0.77)	0.18 (-0.14;0.5)
CHO [E%]**, [3]	-42.38 (-93.05;8.3)	2.74 (-55.78;61.26)
Sucrose [%E]*, [2]	-1.04 (-1.38;-0.7)	-0.96 (-1.34;-0.58)
Dietary fibres [g]*	1.32 (1.16;1.49)	1.28 (1.08;1.48)
Protein [%E]*, [2]	0.24 (0.1;0.38)	0.17 (0;0.34)
Vitamin A [µg]*, [a]	1.59 (1.21;1.97)	1.17 (0.74;1.61)
Beta-Carotene [µg]*, [b]	2.41 (1.89;2.93)	2.16 (1.53;2.79)
Vitamin D [µg]*	0.99 (0.55;1.42)	0.77 (0.26;1.28)
Vitamin E [mg]*, [c]	0.85 (0.6;1.1)	0.72 (0.43;1.02)
Vitamin B1 [mg]*	0.21 (0.01;0.4)	0.03 (-0.21;0.28)
Vitamin B2 [mg]*	0.47 (0.26;0.69)	0.2 (-0.05;0.45)
Niacin [mg]*, [d]	0.32 (0.15;0.49)	0.23 (0.02;0.43)
Panthotenic acid [mg]*	0.7 (0.5;0.9)	0.51 (0.26;0.75)
Vitamin B6 [mg]*	0.61 (0.39;0.83)	0.52 (0.25;0.79)
Biotin [mg]*	0.79 (0.59;0.99)	0.52 (0.28;0.75)
Folate [µg]*, [e]	1.04 (0.84;1.24)	0.8 (0.55;1.04)
Vitamin B12 [µg]*	0.52 (0.23;0.81)	0.21 (-0.1;0.53)
Vitamin C [mg]*	0.99 (0.52;1.46)	0.68 (0.14;1.23)
Sodium [mg]*	0.81 (0.63;0.99)	0.78 (0.56;0.99)
Chloride [mg]*	0.86 (0.69;1.03)	0.8 (0.6;1.01)
Potassium [mg]*	1.01 (0.86;1.17)	0.88 (0.69;1.07)
Calcium [mg]*	0.65 (0.42;0.88)	0.35 (0.09;0.61)
Phosphorus [mg]*	0.62 (0.48;0.76)	0.43 (0.26;0.59)
Magnesium [mg]*	0.75 (0.62;0.89)	0.64 (0.47;0.81)
Iron [mg]*	0.42 (0.29;0.56)	0.34 (0.18;0.5)
Iodine [µg]*	0.91 (0.71;1.11)	0.84 (0.6;1.08)
Zinc [mg]*	0.53 (0.4;0.67)	0.44 (0.29;0.6)
Copper [mg]*	0.57 (0.45;0.7)	0.53 (0.38;0.68)
Manganese [mg]*	1.11 (0.87;1.35)	0.97 (0.67;1.26)

*data presented on the transformed scale (natural logarithm) and multiplied by 10^3 **data multiplied by 10^3
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 36 Food Group Adequacy (FGA) and energy and nutrient intake stratified for age and gender: β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Age 6-9 y	Age 10-12 y	Age 13-15 y	Boys	Girls
n	323	297	140	384	391
Energy [MJ]*, [2]	-0.22 (-0.44;-0.01)	-0.14 (-0.37;0.09)	0.04 (-0.37;0.45)	-0.2 (-0.4;0.01)	-0.02 (-0.24;0.2)
Fat [%E]**, [3]	-22.74 (-88.81;43.34)	23.88 (-44.4;92.17)	34.39 (-72.53;141.32)	-42.61 (-100.12;0)	70.6 (6.79;134.4)
SFA [%E]**, [3]	-25.21 (-59.8;9.38)	30.55 (-6.47;67.57)	29.9 (-26.73;86.52)	-5.44 (-36.58;0)	27.26 (-6.51;61.02)
MUFA [%E]**, [3]	-24.15 (-52.31;4.01)	-12.2 (-39.79;15.4)	6.07 (-35.61;47.76)	-40.58 (-64.81;0)	19.84 (-5.55;45.22)
PUFA[%E]*, [2]	0.51 (0.13;0.89)	0.23 (-0.14;0.59)	0.21 (-0.39;0.8)	0.24 (-0.08;0.56)	0.47 (0.12;0.82)
Cholesterol [mg]*	0.19 (-0.21;0.59)	0.61 (0.4;0.81)	1.02 (0.46;1.59)	0.18 (-0.21;0.56)	0.57 (0.2;0.94)
CHO [E%]**, [3]	-24.29 (-104.5;55.91)	-53.86 (-132.88;25.16)	-20.81 (-144.88;103.25)	19.6 (-50.1;0)	-103.33 (-177.06;-29.6)
Sucrose [%E]*, [2]	-1.43 (-1.95;-0.91)	-1.17 (-1.7;-0.65)	0.09 (-0.82;0.99)	-0.83 (-1.36;-0.31)	-1.24 (-1.67;-0.8)
Dietary fibres [g]*	1.41 (1.16;1.65)	1.48 (1.2;1.76)	0.74 (0.34;1.15)	1.32 (1.07;1.57)	1.33 (1.1;1.55)
Protein [%E]*, [2]	0.34 (0.13;0.55)	0.28 (0.05;0.51)	-0.02 (-0.37;0.33)	0.2 (0;0.39)	0.29 (0.08;0.5)
Vitamin A [µg]*, [a]	1.26 (0.69;1.82)	1.55 (0.93;2.16)	1.97 (1;2.95)	2.02 (1.44;2.59)	1.18 (0.67;1.68)
β-Carotene [µg]*, [b]	2.71 (1.84;3.59)	2.23 (1.41;3.05)	1.85 (0.74;2.97)	2.94 (2.18;3.7)	1.91 (1.19;2.62)
Vitamin D [µg]*	0.46 (-0.22;1.13)	1.2 (0.5;1.9)	1.23 (0.18;2.28)	1.26 (0.65;1.86)	0.67 (0.05;1.3)
Vitamin E [mg]*, [c]	1.01 (0.61;1.41)	0.71 (0.29;1.12)	0.75 (0.19;1.32)	0.9 (0.55;1.25)	0.79 (0.43;1.16)
Vitamin B1 [mg]*	0.2 (-0.13;0.53)	0.1 (-0.2;0.41)	0.41 (-0.04;0.86)	0.08 (-0.2;0.35)	0.33 (0.04;0.61)
Vitamin B2 [mg]*	0.08 (-0.25;0.41)	0.68 (0.33;1.02)	0.69 (0.2;1.18)	0.62 (0.32;0.91)	0.34 (0.03;0.64)
Niacin [mg]*, [d]	0.4 (0.15;0.65)	0.28 (-0.01;0.57)	0.19 (-0.2;0.59)	0.39 (0.16;0.62)	0.25 (0;0.5)
Panthotenic acid [mg]*	0.53 (0.23;0.83)	0.73 (0.37;1.08)	0.91 (0.47;1.35)	0.91 (0.63;1.19)	0.51 (0.22;0.8)
Vitamin B6 [mg]*	0.73 (0.4;1.07)	0.44 (0.06;0.82)	0.72 (0.24;1.19)	0.86 (0.56;1.17)	0.36 (0.05;0.68)
Biotin [mg]*	0.49 (0.17;0.81)	0.92 (0.61;1.22)	1.06 (0.58;1.53)	0.86 (0.57;1.14)	0.71 (0.44;0.99)
Folate [µg]*, [e]	0.74 (0.41;1.07)	1.21 (0.88;1.53)	1.07 (0.63;1.51)	1.24 (0.95;1.53)	0.82 (0.54;1.1)
Vitamin B12 [µg]*	0.03 (-0.41;0.47)	0.64 (0.19;1.08)	0.93 (0.14;1.72)	0.37 (-0.02;0.76)	0.67 (0.24;1.1)
Vitamin C [mg]*	1.02 (0.27;1.76)	1.19 (0.48;1.91)	0.55 (-0.69;1.78)	0.8 (0.12;1.48)	1.19 (0.54;1.84)
Sodium [mg]*	0.84 (0.56;1.11)	0.81 (0.52;1.1)	0.76 (0.35;1.16)	0.8 (0.54;1.05)	0.82 (0.57;1.07)
Chloride [mg]*	0.81 (0.55;1.07)	0.92 (0.64;1.2)	0.79 (0.39;1.18)	0.85 (0.61;1.09)	0.86 (0.62;1.11)
Potassium [mg]*	1.04 (0.8;1.28)	0.96 (0.7;1.22)	1.03 (0.68;1.37)	1.03 (0.81;1.25)	0.99 (0.77;1.21)
Calcium [mg]*	0.11 (-0.24;0.46)	1.17 (0.8;1.54)	0.58 (0.03;1.13)	0.66 (0.34;0.99)	0.62 (0.3;0.95)
Phosphorus [mg]*	0.47 (0.25;0.69)	0.75 (0.53;0.97)	0.65 (0.31;0.98)	0.56 (0.36;0.75)	0.67 (0.47;0.87)
Magnesium [mg]*	0.7 (0.49;0.91)	0.89 (0.67;1.11)	0.56 (0.25;0.87)	0.75 (0.56;0.95)	0.75 (0.56;0.94)
Iron [mg]*	0.49 (0.26;0.72)	0.52 (0.31;0.73)	0.02 (-0.27;0.32)	0.39 (0.18;0.59)	0.45 (0.27;0.64)
Iodine [µg]*	0.86 (0.55;1.18)	0.98 (0.66;1.3)	0.74 (0.27;1.21)	1.13 (0.86;1.41)	0.69 (0.39;0.98)
Zinc [mg]*	0.53 (0.33;0.73)	0.64 (0.43;0.85)	0.37 (0.03;0.72)	0.45 (0.27;0.63)	0.62 (0.43;0.81)
Copper [mg]*	0.56 (0.37;0.75)	0.61 (0.4;0.81)	0.54 (0.24;0.85)	0.57 (0.38;0.75)	0.58 (0.41;0.76)
Manganese [mg]*	1.03 (0.64;1.42)	1.39 (1;1.78)	0.74 (0.26;1.23)	1.11 (0.76;1.45)	1.1 (0.77;1.43)

*data presented on the transformed scale (natural logarithm) and multiplied by 10^3, **data multiplied by 10^3
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 37 Sensitivity analyses for Between-Group Variety 1 (BGV1) applying different cut-offs for mis-reporting (under- and over-reporting): β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Mis-reporter cut-off 1	Mis-reporter cut-off 2
n	741	518
Energy [MJ]*, [2]	0.04 (0.03;0.05)	0.01 (0;0.02)
Fat [%E] [3]	1.11 (0.77;1.45)	0.91 (0.49;1.34)
SFA [%E] [3]	0.46 (0.28;0.64)	0.36 (0.14;0.59)
MUFA [%E] [3]	0.3 (0.16;0.44)	0.21 (0.03;0.38)
PUFA[%E]*, [2]	0.06 (0.04;0.08)	0.06 (0.03;0.08)
Cholesterol [mg]*	0.09 (0.07;0.11)	0.07 (0.05;0.1)
CHO [E%] [3]	-1.55 (-1.94;-1.16)	-1.38 (-1.88;-0.87)
Sucrose [%E]*, [2]	-0.07 (-0.1;-0.05)	-0.06 (-0.1;-0.03)
Dietary fibres [g]*	0.06 (0.05;0.08)	0.06 (0.04;0.08)
Protein [%E]*, [2]	0.03 (0.02;0.05)	0.04 (0.02;0.05)
Vitamin A [µg]*, [a]	0.12 (0.09;0.15)	0.1 (0.07;0.14)
Beta-Carotene [µg]*, [b]	0.2 (0.16;0.24)	0.18 (0.13;0.24)
Vitamin D [µg]*	0.14 (0.1;0.17)	0.15 (0.1;0.19)
Vitamin E [mg]*, [c]	0.08 (0.06;0.1)	0.08 (0.06;0.1)
Vitamin B1 [mg]*	0.01 (-0.01;0.02)	0 (-0.02;0.02)
Vitamin B2 [mg]*	0.03 (0.01;0.04)	0.02 (0;0.04)
Niacin [mg]*, [d]	0.04 (0.02;0.05)	0.04 (0.02;0.05)
Panthotenic acid [mg]*	0.04 (0.03;0.06)	0.04 (0.02;0.07)
Vitamin B6 [mg]*	0.04 (0.02;0.06)	0.04 (0.01;0.06)
Biotin [mg]*	0.06 (0.04;0.07)	0.05 (0.02;0.07)
Folate [µg]*, [e]	0.07 (0.06;0.09)	0.07 (0.05;0.09)
Vitamin B12 [µg]*	0.09 (0.07;0.11)	0.09 (0.07;0.12)
Vitamin C [mg]*	0.1 (0.06;0.13)	0.08 (0.03;0.13)
Sodium [mg]*	0.06 (0.05;0.08)	0.06 (0.04;0.07)
Chloride [mg]*	0.07 (0.05;0.08)	0.06 (0.04;0.07)
Potassium [mg]*	0.06 (0.05;0.07)	0.05 (0.03;0.07)
Calcium [mg]*	0.03 (0.01;0.05)	0.02 (0;0.05)
Phosphorus [mg]*	0.05 (0.03;0.06)	0.04 (0.02;0.05)
Magnesium [mg]*	0.03 (0.02;0.05)	0.03 (0.01;0.04)
Iron [mg]*	0.03 (0.02;0.04)	0.02 (0;0.03)
Iodine [µg]*	0.11 (0.1;0.13)	0.11 (0.1;0.13)
Zinc [mg]*	0.04 (0.03;0.05)	0.04 (0.02;0.05)
Copper [mg]*	0.02 (0.01;0.04)	0.02 (0.01;0.03)
Manganese [mg]*	0.04 (0.02;0.06)	0.03 (0;0.06)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 38 Between-Group Variety 1 (BGV1) and energy and nutrient intake stratified for age and gender: β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Age 6-9 y	Age 10-12 y	Age 13-15 y	Boys	Girls
n	304	297	140	372	369
Energy [MJ]*, [2]	0.03 (0.01;0.04)	0.04 (0.03;0.06)	0.05 (0.02;0.07)	0.03 (0.02;0.05)	0.05 (0.03;0.07)
Fat [%E] [3]	1.3 (0.73;1.87)	1.12 (0.59;1.66)	0.75 (0.01;1.48)	0.67 (0.21;0)	1.58 (1.08;2.07)
SFA [%E] [3]	0.48 (0.17;0.78)	0.57 (0.28;0.85)	0.26 (-0.12;0.64)	0.31 (0.06;0)	0.62 (0.36;0.89)
MUFA [%E] [3]	0.4 (0.16;0.65)	0.25 (0.03;0.48)	0.18 (-0.1;0.46)	0.13 (-0.07;0)	0.48 (0.28;0.68)
PUFA[%E]*, [2]	0.06 (0.03;0.09)	0.06 (0.03;0.09)	0.06 (0.01;0.1)	0.04 (0.02;0.07)	0.07 (0.05;0.1)
Cholesterol [mg]*	0.1 (0.07;0.14)	0.07 (0.03;0.1)	0.09 (0.05;0.13)	0.09 (0.06;0.11)	0.08 (0.05;0.11)
CHO [E%] [3]	-1.89 (-2.57;-1.21)	-1.55 (-2.16;-0.93)	-0.95 (-1.8;-0.1)	-1.03 (-1.58;0)	-2.11 (-2.68;-1.55)
Sucrose [%E]*, [2]	-0.08 (-0.12;-0.03)	-0.09 (-0.13;-0.05)	-0.05 (-0.1;0.01)	-0.05 (-0.09;-0.02)	-0.09 (-0.13;-0.06)
Dietary fibres [g]*	0.05 (0.02;0.07)	0.08 (0.06;0.11)	0.05 (0.02;0.08)	0.06 (0.04;0.08)	0.07 (0.05;0.09)
Protein [%E]*, [2]	0.04 (0.03;0.06)	0.03 (0.02;0.05)	0.02 (-0.01;0.04)	0.03 (0.01;0.04)	0.04 (0.02;0.06)
Vitamin A [µg]*, [a]	0.13 (0.08;0.18)	0.1 (0.05;0.16)	0.14 (0.07;0.21)	0.13 (0.08;0.18)	0.12 (0.08;0.16)
Beta-Carotene [µg]*, [b]	0.22 (0.14;0.29)	0.19 (0.12;0.26)	0.2 (0.12;0.27)	0.22 (0.16;0.28)	0.18 (0.12;0.24)
Vitamin D [µg]*	0.16 (0.1;0.21)	0.13 (0.07;0.18)	0.12 (0.04;0.19)	0.15 (0.11;0.2)	0.12 (0.07;0.17)
Vitamin E [mg]*, [c]	0.09 (0.06;0.13)	0.08 (0.04;0.11)	0.06 (0.02;0.1)	0.07 (0.05;0.1)	0.08 (0.05;0.11)
Vitamin B1 [mg]*	0 (-0.03;0.03)	0 (-0.03;0.02)	0.02 (-0.01;0.06)	0.01 (-0.02;0.03)	0.01 (-0.01;0.03)
Vitamin B2 [mg]*	0 (-0.03;0.03)	0.03 (0;0.06)	0.05 (0.01;0.08)	0.03 (0.01;0.06)	0.02 (0;0.05)
Niacin [mg]*, [d]	0.04 (0.02;0.06)	0.03 (0.01;0.05)	0.03 (0.01;0.06)	0.04 (0.03;0.06)	0.03 (0.01;0.05)
Panthotenic acid [mg]*	0.03 (0.01;0.06)	0.04 (0.01;0.07)	0.06 (0.03;0.09)	0.06 (0.04;0.08)	0.03 (0;0.06)
Vitamin B6 [mg]*	0.03 (0;0.06)	0.03 (0;0.06)	0.06 (0;0.1)	0.06 (0.04;0.08)	0.02 (-0.01;0.05)
Biotin [mg]*	0.05 (0.02;0.08)	0.06 (0.03;0.08)	0.07 (0.03;0.1)	0.06 (0.04;0.09)	0.05 (0.03;0.08)
Folate [µg]*, [e]	0.06 (0.03;0.09)	0.09 (0.06;0.11)	0.06 (0.03;0.09)	0.09 (0.06;0.11)	0.06 (0.03;0.08)
Vitamin B12 [µg]*	0.1 (0.06;0.13)	0.08 (0.04;0.11)	0.08 (0.03;0.14)	0.08 (0.04;0.11)	0.11 (0.08;0.15)
Vitamin C [mg]*	0.14 (0.07;0.21)	0.1 (0.04;0.16)	0.04 (-0.05;0.14)	0.09 (0.04;0.15)	0.1 (0.05;0.16)
Sodium [mg]*	0.07 (0.05;0.09)	0.07 (0.05;0.09)	0.04 (0.01;0.07)	0.06 (0.04;0.08)	0.06 (0.04;0.08)
Chloride [mg]*	0.06 (0.04;0.09)	0.07 (0.05;0.1)	0.04 (0.02;0.07)	0.06 (0.04;0.08)	0.07 (0.05;0.09)
Potassium [mg]*	0.06 (0.03;0.08)	0.06 (0.04;0.09)	0.05 (0.03;0.08)	0.06 (0.04;0.08)	0.06 (0.04;0.08)
Calcium [mg]*	0.01 (-0.02;0.04)	0.06 (0.03;0.09)	0.02 (-0.03;0.06)	0.03 (0;0.05)	0.04 (0.01;0.07)
Phosphorus [mg]*	0.05 (0.03;0.07)	0.05 (0.03;0.07)	0.04 (0.01;0.06)	0.04 (0.03;0.06)	0.05 (0.03;0.07)
Magnesium [mg]*	0.03 (0.01;0.05)	0.04 (0.02;0.06)	0.02 (0;0.05)	0.03 (0.01;0.05)	0.04 (0.02;0.05)
Iron [mg]*	0.03 (0.01;0.05)	0.03 (0.01;0.05)	0.02 (-0.01;0.04)	0.02 (0.01;0.04)	0.03 (0.02;0.05)
Iodine [µg]*	0.14 (0.11;0.16)	0.11 (0.08;0.13)	0.08 (0.05;0.11)	0.12 (0.1;0.14)	0.11 (0.09;0.13)
Zinc [mg]*	0.04 (0.03;0.06)	0.05 (0.03;0.06)	0.03 (0.01;0.06)	0.04 (0.02;0.05)	0.05 (0.03;0.06)
Copper [mg]*	0.03 (0.01;0.04)	0.03 (0.01;0.05)	0.02 (-0.01;0.04)	0.02 (0.01;0.04)	0.03 (0.01;0.05)
Manganese [mg]*	0.03 (-0.01;0.06)	0.06 (0.03;0.1)	0.04 (0.01;0.08)	0.04 (0.01;0.07)	0.05 (0.02;0.08)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 39 Sensitivity analyses for Between-Group Variety 2 (BGV2) applying different cut-offs for mis-reporting (under- and over-reporting): β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Mis-reporter cut-off 1	Mis-reporter cut-off 2
n	741	518
Energy [MJ]*, [2]	0.06 (0.05;0.08)	0.03 (0.01;0.04)
Fat [%E] [3]	1.36 (0.95;1.77)	1.27 (0.75;1.8)
SFA [%E] [3]	0.58 (0.36;0.8)	0.56 (0.28;0.84)
MUFA [%E] [3]	0.34 (0.17;0.51)	0.3 (0.08;0.52)
PUFA[%E]*, [2]	0.07 (0.05;0.09)	0.07 (0.04;0.1)
Cholesterol [mg]*	0.16 (0.14;0.18)	0.15 (0.12;0.18)
CHO [E%] [3]	-1.81 (0.24;-2.29)	-1.77 (-2.39;-1.15)
Sucrose [%E]*, [2]	-0.03 (-0.06;0)	-0.03 (-0.07;0.01)
Dietary fibres [g]*	0.04 (0.02;0.06)	0.03 (0.01;0.06)
Protein [%E]*, [2]	0.03 (0.02;0.05)	0.04 (0.02;0.06)
Vitamin A [µg]*, [a]	0.13 (0.09;0.17)	0.11 (0.07;0.16)
Beta-Carotene [µg]*, [b]	0.21 (0.16;0.27)	0.17 (0.1;0.24)
Vitamin D [µg]*	0.27 (0.23;0.31)	0.3 (0.25;0.34)
Vitamin E [mg]*, [c]	0.1 (0.07;0.12)	0.09 (0.05;0.12)
Vitamin B1 [mg]*	0.01 (-0.01;0.03)	-0.01 (-0.03;0.02)
Vitamin B2 [mg]*	0.03 (0.01;0.05)	0.01 (-0.01;0.04)
Niacin [mg]*, [d]	0.04 (0.03;0.06)	0.04 (0.02;0.06)
Panthotenic acid [mg]*	0.05 (0.03;0.07)	0.04 (0.01;0.07)
Vitamin B6 [mg]*	0.04 (0.02;0.07)	0.02 (-0.01;0.05)
Biotin [mg]*	0.08 (0.06;0.1)	0.07 (0.04;0.09)
Folate [µg]*, [e]	0.07 (0.05;0.1)	0.05 (0.02;0.07)
Vitamin B12 [µg]*	0.13 (0.11;0.16)	0.13 (0.1;0.16)
Vitamin C [mg]*	0.12 (0.07;0.17)	0.08 (0.02;0.14)
Sodium [mg]*	0.05 (0.03;0.06)	0.04 (0.01;0.06)
Chloride [mg]*	0.05 (0.03;0.07)	0.04 (0.01;0.06)
Potassium [mg]*	0.06 (0.04;0.08)	0.05 (0.02;0.07)
Calcium [mg]*	0.02 (0;0.04)	0 (-0.02;0.03)
Phosphorus [mg]*	0.04 (0.02;0.05)	0.03 (0.01;0.04)
Magnesium [mg]*	0.02 (0.01;0.04)	0.01 (-0.01;0.03)
Iron [mg]*	0.03 (0.02;0.05)	0.02 (0;0.04)
Iodine [µg]*	0.13 (0.11;0.15)	0.13 (0.11;0.16)
Zinc [mg]*	0.04 (0.02;0.05)	0.03 (0.01;0.05)
Copper [mg]*	0.02 (0.01;0.04)	0.02 (0;0.03)
Manganese [mg]*	0.02 (0;0.05)	0 (-0.03;0.04)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 40 Between-Group Variety 2 (BGV2) and energy and nutrient intake stratified for age and gender: β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and total food and beverage intake)

	Age 6-9 y	Age 10-12 y	Age 13-15 y	Boys	Girls
n	304	297	140	372	369
Energy [MJ]*, [2]	0.05 (0.02;0.07)	0.07 (0.04;0.09)	0.07 (0.04;0.11)	0.04 (0.02;0.06)	0.08 (0.06;0.11)
Fat [%E] [3]	1.5 (0.85;2.15)	1.26 (0.6;1.92)	1.15 (0.22;2.09)	0.83 (0.27;1.07)	1.92 (1.32;2.52)
SFA [%E] [3]	0.49 (0.14;0.84)	0.62 (0.26;0.97)	0.58 (0.09;1.07)	0.48 (0.18;1.08)	0.68 (0.36;1)
MUFA [%E] [3]	0.56 (0.28;0.84)	0.17 (-0.1;0.45)	0.24 (-0.13;0.6)	0.09 (-0.15;1.09)	0.62 (0.37;0.86)
PUFA[%E]*, [2]	0.06 (0.02;0.1)	0.08 (0.05;0.12)	0.06 (0.01;0.12)	0.05 (0.02;0.08)	0.1 (0.06;0.13)
Cholesterol [mg]*	0.1 (0.07;0.14)	0.07 (0.03;0.1)	0.09 (0.05;0.13)	0.09 (0.06;0.11)	0.08 (0.05;0.11)
CHO [E%] [3]	-1.92 (-2.71;-1.14)	-1.82 (-2.57;-1.07)	-1.35 (-2.44;-0.26)	-1.23 (-1.9;1.05)	-2.46 (-3.15;-1.76)
Sucrose [%E]*, [2]	-0.04 (-0.09;0.02)	-0.03 (-0.09;0.02)	-0.01 (-0.08;0.06)	0 (-0.05;0.05)	-0.07 (-0.11;-0.02)
Dietary fibres [g]*	0.03 (0;0.06)	0.05 (0.01;0.08)	0.05 (0.01;0.09)	0.04 (0.01;0.07)	0.05 (0.02;0.08)
Protein [%E]*, [2]	0.03 (0.01;0.05)	0.04 (0.02;0.06)	0.02 (-0.01;0.05)	0.03 (0.01;0.05)	0.04 (0.02;0.06)
Vitamin A [µg]*, [a]	0.09 (0.03;0.15)	0.13 (0.07;0.19)	0.19 (0.1;0.28)	0.14 (0.08;0.2)	0.13 (0.07;0.18)
Beta-Carotene [µg]*, [b]	0.19 (0.1;0.28)	0.24 (0.16;0.33)	0.18 (0.08;0.29)	0.23 (0.16;0.31)	0.2 (0.13;0.28)
Vitamin D [µg]*	0.28 (0.22;0.34)	0.25 (0.19;0.31)	0.29 (0.2;0.37)	0.27 (0.22;0.32)	0.27 (0.21;0.32)
Vitamin E [mg]*, [c]	0.09 (0.05;0.13)	0.12 (0.07;0.16)	0.07 (0.02;0.12)	0.08 (0.04;0.11)	0.12 (0.08;0.16)
Vitamin B1 [mg]*	0 (-0.03;0.04)	0.01 (-0.03;0.04)	0.01 (-0.03;0.06)	0 (-0.03;0.02)	0.02 (-0.01;0.05)
Vitamin B2 [mg]*	-0.03 (-0.07;0)	0.06 (0.02;0.09)	0.07 (0.02;0.11)	0.04 (0.01;0.07)	0.02 (-0.02;0.05)
Niacin [mg]*, [d]	0.03 (0;0.05)	0.06 (0.03;0.08)	0.03 (0;0.07)	0.05 (0.02;0.07)	0.04 (0.01;0.07)
Panthothenic acid [mg]*	0.02 (-0.01;0.05)	0.07 (0.03;0.11)	0.08 (0.03;0.12)	0.06 (0.03;0.09)	0.05 (0.01;0.08)
Vitamin B6 [mg]*	0.01 (-0.03;0.04)	0.07 (0.03;0.11)	0.05 (0.01;0.1)	0.06 (0.03;0.09)	0.02 (-0.01;0.06)
Biotin [mg]*	0.05 (0.02;0.09)	0.09 (0.06;0.12)	0.11 (0.07;0.15)	0.09 (0.06;0.11)	0.08 (0.05;0.11)
Folate [µg]*, [e]	0.05 (0.01;0.08)	0.1 (0.06;0.13)	0.07 (0.02;0.11)	0.09 (0.06;0.12)	0.05 (0.02;0.08)
Vitamin B12 [µg]*	0.13 (0.09;0.17)	0.13 (0.08;0.17)	0.13 (0.06;0.21)	0.11 (0.08;0.15)	0.16 (0.12;0.21)
Vitamin C [mg]*	0.13 (0.06;0.21)	0.12 (0.05;0.2)	0.07 (-0.05;0.19)	0.1 (0.03;0.16)	0.15 (0.08;0.22)
Sodium [mg]*	0.06 (0.03;0.08)	0.04 (0.01;0.07)	0.02 (-0.02;0.06)	0.05 (0.02;0.07)	0.05 (0.02;0.08)
Chloride [mg]*	0.04 (0.02;0.07)	0.05 (0.02;0.08)	0.04 (0;0.08)	0.05 (0.02;0.07)	0.05 (0.03;0.08)
Potassium [mg]*	0.04 (0.01;0.06)	0.08 (0.05;0.11)	0.05 (0.01;0.08)	0.06 (0.04;0.09)	0.06 (0.03;0.08)
Calcium [mg]*	-0.04 (-0.08;-0.01)	0.06 (0.02;0.1)	0.05 (-0.01;0.1)	0.03 (0;0.06)	0.01 (-0.02;0.05)
Phosphorus [mg]*	0.03 (0.01;0.05)	0.04 (0.02;0.07)	0.05 (0.01;0.08)	0.04 (0.02;0.06)	0.04 (0.02;0.06)
Magnesium [mg]*	0.01 (-0.01;0.03)	0.04 (0.01;0.06)	0.03 (0;0.06)	0.03 (0.01;0.05)	0.02 (0;0.04)
Iron [mg]*	0.03 (0.01;0.05)	0.04 (0.02;0.06)	0.02 (-0.01;0.05)	0.01 (-0.01;0.03)	0.05 (0.03;0.07)
Iodine [µg]*	0.13 (0.1;0.16)	0.15 (0.12;0.18)	0.09 (0.05;0.13)	0.14 (0.11;0.16)	0.13 (0.1;0.16)
Zinc [mg]*	0.03 (0.01;0.06)	0.03 (0.01;0.06)	0.04 (0.01;0.07)	0.03 (0.01;0.04)	0.05 (0.03;0.07)
Copper [mg]*	0.02 (0;0.04)	0.03 (0;0.05)	0.02 (-0.01;0.05)	0.03 (0.01;0.05)	0.02 (0;0.04)
Manganese [mg]*	0.02 (-0.02;0.07)	0.03 (-0.01;0.07)	0.02 (-0.03;0.07)	0.03 (-0.01;0.06)	0.02 (-0.02;0.05)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 41 Sensitivity analyses for Fruit and Vegetable Variety (FVV) applying different cut-offs for mis-reporting (under- and over-reporting): β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and fruit and vegetable intake)

	Mis-reporter cut-off 1	Mis-reporter cut-off 2
n	721	508
Energy [MJ]*, [2]	0.02 (0.01;0.03)	0.01 (0;0.01)
Fat [%E] [3]	0.19 (-0.07;0.45)	0.15 (-0.12;0.43)
SFA [%E] [3]	0.09 (-0.04;0.22)	0.06 (-0.08;0.21)
MUFA [%E] [3]	0.02 (-0.09;0.12)	-0.01 (-0.12;0.11)
PUFA[%E]*, [2]	0.02 (0;0.03)	0.02 (0;0.03)
Cholesterol [mg]*	0.00 (-0.02;0.01)	0 (-0.02;0.01)
CHO [E%] [3]	-0.19 (-0.5;0.11)	-0.26 (-0.59;0.07)
Sucrose [%E]*, [2]	0.01 (-0.01;0.03)	-0.01 (-0.03;0.02)
Dietary fibres [g]*	0.06 (0.04;0.07)	0.05 (0.04;0.07)
Protein [%E]*, [2]	0 (-0.01;0.01)	0.01 (0;0.02)
Vitamin A [µg]*, [a]	0.09 (0.06;0.11)	0.1 (0.07;0.12)
Beta-Carotene [µg]*, [b]	0.17 (0.15;0.2)	0.18 (0.15;0.21)
Vitamin D [µg]*	0.01 (-0.02;0.03)	0.01 (-0.02;0.04)
Vitamin E [mg]*, [c]	0.03 (0.02;0.04)	0.03 (0.01;0.04)
Vitamin B1 [mg]*	0 (-0.01;0.01)	0 (-0.02;0.01)
Vitamin B2 [mg]*	0.01 (0;0.03)	0.01 (0;0.02)
Niacin [mg]*, [d]	0.01 (0;0.02)	0.02 (0;0.03)
Panthotenic acid [mg]*	0.03 (0.01;0.04)	0.02 (0.01;0.04)
Vitamin B6 [mg]*	0.03 (0.02;0.05)	0.03 (0.02;0.05)
Biotin [mg]*	0.02 (0.01;0.03)	0.02 (0.01;0.03)
Folate [µg]*, [e]	0.03 (0.02;0.04)	0.03 (0.01;0.04)
Vitamin B12 [µg]*	0 (-0.02;0.02)	0.01 (0;0.03)
Vitamin C [mg]*	0.07 (0.04;0.09)	0.06 (0.04;0.09)
Sodium [mg]*	0.02 (0.01;0.03)	0.03 (0.02;0.04)
Chloride [mg]*	0.02 (0.01;0.03)	0.03 (0.02;0.04)
Potassium [mg]*	0.03 (0.02;0.04)	0.03 (0.02;0.04)
Calcium [mg]*	0.02 (0;0.03)	0.02 (0;0.03)
Phosphorus [mg]*	0.01 (0;0.02)	0.01 (0.01;0.02)
Magnesium [mg]*	0.02 (0.01;0.03)	0.02 (0.01;0.03)
Iron [mg]*	0.02 (0.01;0.02)	0.02 (0.01;0.02)
Iodine [µg]*	0.03 (0.02;0.04)	0.03 (0.02;0.05)
Zinc [mg]*	0.02 (0.01;0.02)	0.02 (0.01;0.03)
Copper [mg]*	0.01 (0.01;0.02)	0.02 (0.01;0.02)
Manganese [mg]*	0.03 (0.01;0.04)	0.03 (0.01;0.04)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and fruit and vegetable intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Table 42 Fruit and Vegetable Variety (FVV) and energy and nutrient intake stratified for age and gender: β-coefficients (95% CI) of energy and selected nutrients derived from multiple linear regression models (adjusted for total energy intake, age, gender, BMI, and fruit and vegetable intake)

	Age 6-9 y	Age 10-12 y	Age 13-15 y	Boys	Girls
n	296	287	138	359	362
Energy [MJ]*, [2]	0.02 (0;0.04)	0.01 (-0.01;0.03)	0.02 (0;0.05)	0.02 (0;0.03)	0.02 (0;0.03)
Fat [%E] [3]	0.09 (-0.31;0.49)	0.11 (-0.31;0.54)	0.43 (-0.17;1.02)	0.07 (-0.26;1.04)	0.32 (-0.08;0.71)
SFA [%E] [3]	0.04 (-0.17;0.24)	0.11 (-0.12;0.33)	0.13 (-0.18;0.44)	0.01 (-0.17;1.04)	0.18 (-0.02;0.38)
MUFA [%E] [3]	0 (-0.17;0.16)	-0.02 (-0.19;0.15)	0.11 (-0.12;0.34)	-0.07 (-0.2;1.04)	0.11 (-0.05;0.27)
PUFA[%E]*, [2]	0.01 (-0.01;0.04)	0.01 (-0.01;0.03)	0.03 (0;0.06)	0.03 (0.01;0.04)	0.01 (-0.02;0.03)
Cholesterol [mg]*	0.00 (-0.03;0.02)	-0.02 (-0.04;0.01)	0.00 (-0.03;0.04)	0.01 (-0.01;0.03)	-0.02 (-0.04;0.01)
CHO [E%] [3]	-0.05 (-0.54;0.44)	-0.21 (-0.71;0.29)	-0.35 (-1.04;0.34)	-0.07 (-0.47;1.03)	-0.34 (-0.8;0.13)
Sucrose [%E]*, [2]	0.02 (-0.02;0.05)	0.01 (-0.03;0.04)	0 (-0.04;0.05)	0.01 (-0.02;0.04)	0.01 (-0.02;0.04)
Dietary fibres [g]*	0.04 (0.02;0.06)	0.06 (0.05;0.08)	0.05 (0.03;0.07)	0.05 (0.04;0.07)	0.06 (0.04;0.07)
Protein [%E]*, [2]	0 (-0.01;0.01)	0.01 (0;0.03)	0 (-0.02;0.02)	0 (-0.01;0.01)	0.01 (-0.01;0.02)
Vitamin A [µg]*, [a]	0.08 (0.05;0.11)	0.09 (0.06;0.13)	0.07 (0.01;0.12)	0.09 (0.06;0.13)	0.08 (0.05;0.11)
Beta-Carotene [µg]*, [b]	0.17 (0.12;0.21)	0.2 (0.16;0.24)	0.13 (0.07;0.18)	0.18 (0.14;0.22)	0.17 (0.13;0.21)
Vitamin D [µg]*	0.02 (-0.02;0.06)	-0.02 (-0.06;0.02)	0.01 (-0.05;0.07)	0.02 (-0.01;0.06)	-0.02 (-0.05;0.02)
Vitamin E [mg]*, [c]	0.02 (0;0.05)	0.03 (0;0.05)	0.04 (0.01;0.07)	0.04 (0.02;0.06)	0.02 (-0.01;0.04)
Vitamin B1 [mg]*	-0.02 (-0.04;0)	0.01 (-0.01;0.03)	0 (-0.02;0.03)	0 (-0.02;0.01)	0 (-0.02;0.02)
Vitamin B2 [mg]*	0.01 (-0.01;0.03)	0.02 (0;0.04)	0 (-0.03;0.03)	0.02 (0;0.03)	0.01 (-0.01;0.03)
Niacin [mg]*, [d]	0.01 (-0.01;0.02)	0.01 (0;0.03)	0.01 (-0.01;0.03)	0.02 (0;0.03)	0.01 (0;0.03)
Panthotenic acid [mg]*	0.02 (0;0.04)	0.03 (0.01;0.05)	0.02 (0;0.05)	0.03 (0.01;0.05)	0.02 (0;0.04)
Vitamin B6 [mg]*	0.02 (0;0.04)	0.03 (0.01;0.05)	0.05 (0.03;0.07)	0.04 (0.02;0.05)	0.03 (0.01;0.05)
Biotin [mg]*	0.02 (0;0.04)	0.02 (0.01;0.04)	0.02 (-0.01;0.04)	0.02 (0.01;0.04)	0.03 (0.01;0.04)
Folate [µg]*, [e]	0.03 (0.01;0.05)	0.04 (0.02;0.06)	0.02 (0;0.05)	0.03 (0.02;0.05)	0.03 (0.02;0.05)
Vitamin B12 [µg]*	0 (-0.03;0.03)	0 (-0.03;0.03)	-0.01 (-0.05;0.04)	0 (-0.02;0.02)	0 (-0.03;0.03)
Vitamin C [mg]*	0.07 (0.03;0.11)	0.04 (0.01;0.08)	0.09 (0.03;0.15)	0.06 (0.03;0.1)	0.07 (0.04;0.1)
Sodium [mg]*	0.02 (0;0.04)	0.01 (0;0.03)	0.03 (0;0.05)	0.02 (0.01;0.04)	0.02 (0;0.03)
Chloride [mg]*	0.02 (0.01;0.04)	0.02 (0;0.04)	0.03 (0.01;0.05)	0.02 (0.01;0.04)	0.02 (0.01;0.04)
Potassium [mg]*	0.02 (0.01;0.03)	0.03 (0.02;0.04)	0.03 (0.01;0.04)	0.03 (0.02;0.04)	0.03 (0.02;0.04)
Calcium [mg]*	0.02 (0;0.04)	0.03 (0.01;0.05)	-0.01 (-0.04;0.02)	0.02 (0;0.04)	0.02 (0;0.04)
Phosphorus [mg]*	0.01 (0;0.02)	0.01 (0;0.03)	0 (-0.02;0.02)	0.01 (0;0.02)	0.01 (0;0.02)
Magnesium [mg]*	0.01 (0;0.03)	0.02 (0.01;0.04)	0.01 (-0.01;0.03)	0.02 (0.01;0.03)	0.02 (0.01;0.03)
Iron [mg]*	0.01 (-0.01;0.02)	0.02 (0;0.03)	0.02 (0;0.03)	0.02 (0.01;0.03)	0.01 (0;0.03)
Iodine [µg]*	0.04 (0.02;0.06)	0.02 (0;0.05)	0.02 (-0.01;0.05)	0.04 (0.02;0.05)	0.02 (0;0.04)
Zinc [mg]*	0.01 (-0.01;0.02)	0.02 (0.01;0.03)	0.02 (0;0.04)	0.02 (0.01;0.03)	0.01 (0;0.03)
Copper [mg]*	0.01 (0;0.02)	0.01 (0;0.03)	0.01 (-0.01;0.04)	0.02 (0;0.03)	0.01 (0;0.03)
Manganese [mg]*	0.01 (-0.01;0.04)	0.03 (0.01;0.06)	0.04 (0.01;0.07)	0.03 (0.01;0.05)	0.02 (0;0.04)

*data presented on the transformed scale (natural logarithm)
SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA Polyunsaturated fatty acids, CHO Carbohydrates
[1]adjusted for age, gender, BMI, and total food and beverage intake; [2]arithmetic mean, adjusted for gender, age, BMI, total food and beverage intake; [a]retinol-equivalent= Retinol=6 all-trans-beta-Carotin; [b]this value is included as times 0.16 in retinol-equivalents; [c]RRR-α-tocopherol-equivalent= α-tocopherol + β-tocopherol x 0,5 + γ-Tocopherol x 0,25 + α-Tocotrienol x 0,33; [d]niacin-equivalent (NE)=1 niacin=60 tryptophan; [e]1 dietary folate=0.5 pteroylmonoglutamat;

Annex

Annex 2: Food Record

Annex

S34

ÖSES
kid07

Dein Ernährungsprotokoll

universität
wien

Liebe Eltern!

Es ist mittlerweile unumstritten, dass eine ausgewogene Ernährung die Gesundheit und die Entwicklung unserer Kinder positiv beeinflussen kann.

Deshalb wird auch im nächsten österreichischen Ernährungsbericht, der im Auftrag des **Bundesministeriums für Gesundheit, Familie und Jugend** durchgeführt wird, besonderes Augenmerk auf die Ernährungssituation unserer Schulkinder gelegt. Das Department für Ernährungswissenschaften der Universität Wien wurde mit der Durchführung der entsprechenden Erhebungsstudien betraut.

Mit einem Ernährungsprotokoll möchten wir an 3 aufeinander folgenden Tagen die **tatsächliche Nahrungsaufnahme Ihres Kindes** erfassen. Nur **durch Ihre Mithilfe** lassen sich aussagekräftige Ergebnisse erzielen und daher bitten wir Sie um Unterstützung.

Ihr Kind hat bereits in der Schule einen Fragebogen zu den Themen Essgewohnheiten, Freizeit, Bewegung, Obst und Gemüse etc. ausgefüllt. Als Hausaufgabe hat Ihr Kind ein so genanntes 3-Tage-Ernährungsprotokoll (Schätzprotokoll) mit nach Hause gebracht. Wir haben Ihr Kind gebeten **gemeinsam mit Ihnen** ALLES, WAS es an den angegebenen Tagen ISST und TRINKT, aufzuschreiben.

Da Ihr Kind noch recht jung ist und eventuell Schwierigkeiten dabei hat, das Protokoll selbstständig zu führen, bitten wir Sie, Ihrem Kind **beim Ausfüllen behilflich** zu sein.

Im Folgenden finden Sie Tipps zum Ausfüllen des Protokolls.

Herzlichen Dank im Voraus!
Mit freundlichen Grüßen

Univ.-Prof. Dr. I. Elmadfa

Vorstand des Departments für Ernährungswissenschaften
Universität Wien

Liebes Schulkind!

Im Rahmen der ÖSES.kid-Studie sind wir am Ernährungsverhalten von Schulkindern besonders interessiert. Wir bitten Dich deshalb, an **3 aufeinander folgenden Tagen** ein **Ernährungsprotokoll** zu führen und dieses Protokoll wieder ausgefüllt in die Schule mitzubringen.

Dein/e Klassenlehrer/in wird die Protokolle am ……………………………. wieder einsammeln.

Wie führe ich ein Ernährungsprotokoll?

Bitte schreib auf der nächsten Seite **ALLES** auf, was Du an den jeweiligen Tagen **ISST** und **TRINKST** hast (auch die kleinen Snacks zwischendurch nicht vergessen!). Es ist uns sehr **wichtig**, dass Du Deine **Ernährungsgewohnheiten** in dieser Zeit **nicht veränderst**! Iss einfach so weiter, wie bisher und schreib nach jeder Mahlzeit auf, welche Lebensmittel oder Getränke Du konsumiert hast.

Und so wird's gemacht:

1. Fülle Dein Protokoll nach jeder Mahlzeit aus. Notiere alles, was Du zu dieser Mahlzeit gegessen oder getrunken hast.
2. Beschreibe die Lebensmittel oder Getränke so genau wie möglich. Zum Beispiel:

   Joghurt 1%, Vollkornbrot mit Sesam, geschälter Apfel, Hot Dog nur mit Ketschup, Bananenmilch mit Zucker, Tee mit Zitrone, usw.
   Wenn Du willst kannst Du auch den Namen der Marke angeben z.B. Iglo Fischstäbchen, Milka Schokolade, Nöm Kakao, Manner Schnitten
3. Schätze Deine **Portionsgröße** so genau wie möglich!

   Erinnere Dich genau, wie viel Du gegessen oder getrunken hast und schreibe die Menge in die **Spalte „ungefähre Menge“**.

   Die beigefügten **Fotos können Dir helfen**, Deine Portionsgrößen besser abzuschätzen. Die Portionsgrößen „klein“, „mittel“ und groß“ können diesen Bildern entnommen werden.

   Natürlich kannst Du Deine Verzehrsmengen noch genauer angeben, indem Du haushaltsübliche Maße verwendest, wie zum Beispiel:

   - Teelöffel (TL), Esslöffel (EL)
   - Scheibe Brot, Stück (z.B. ganzer Apfel)
   - Tasse (= Häferl), Glas, Schüssel, Teller => **siehe Fotos**
   - Falls Du die Menge genau weißt, kannst Du uns Deine Portionsgröße selbstverständlich auch in Gramm (g) oder Milliliter (ml) angeben.

TIPP: Nimm Dein Protokoll überall hin mit, damit Du alle Speisen und Getränke gleich aufschreiben kannst!

Ausfüllhilfe

Das ist nur ein Übungsbeispiel:

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Mittagessen	3 Stück	Fischstäbchen (iglo)
	1 Portion **mittel**	Kartoffeln
	1 Portion **klein**	Erbsen
	1 Portion **mittel**	Grüner Salat mit Essig-Öl-Dressing
	1 Schüssel **klein**	Himbeeren
	2 Gläser **mittel**	Apfelsaft gespritzt
	Wo? ☐ zu Hause ☒ woanders, schreib wo: im Restaurant ______	
Nachmittagsjause	1 Häferl **groß** (ODER 300ml)	Vanillemilch (Müllermilch)
	1 Scheibe **mittel**	Schwarzbrot
	1 Portion **klein**	Schinken
	1 Portion **klein**	Tilsiter (45% F.i.T)
	1 Glas **mittel** (oder 250 ml)	Leitungswasser
	Wo? ☒ zu Hause ☐ woanders, schreib wo: _____________	

ACHTUNG:
Vergleiche die Portionen mit den Portionsgrößen auf den Fotos!

Meine Mahlzeiten waren heute *(bitte ankreuzen)*

☐ wie immer ☐ anders als sonst

ACHTUNG: Kreuze dieses Kästchen an, wenn Du heute ganz anders als sonst gegessen hast! z.B. Kindergeburtstag,…

Für Anmerkungen und Besonderheiten (alles, was Du uns in Bezug auf Deine Mahlzeiten willst) benutze das Kästchen „**Besonderheiten/Bemerkungen/Sonstiges**"

!!! Weitere Tipps finden Sie auf der letzten Seite!!!

Angaben zum 1. Protokoll TAG 1

Datum: _ _ _ _ _ _ _ _ _ _ _ _ _ **Ist heute ein Schultag?** ☐ Ja ☐ Nein

Wochentag: ☐ Montag ☐ Dienstag ☐ Mittwoch ☐ Donnerstag ☐ Freitag ☐ Samstag ☐ Sonntag

Jetzt bist Du an der Reihe!

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Frühstück		
		Hast Du auch nicht auf Getränke vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Vormittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Mittagessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Nachmittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Abendessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Spätmahlzeit		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Meine Mahlzeiten waren heute *(bitte ankreuzen)*

☐ wie immer ☐ anders als sonst

Besonderheiten/Bemerkungen/Sonstiges:

✎ **Angaben zum 2. Protokoll** **TAG 2**

Datum: _ _ _ _ _ _ _ _ _ _ _ _ _ **Ist heute ein Schultag?** ☐ Ja ☐ Nein

Wochentag: ☐ Montag ☐ Dienstag ☐ Mittwoch ☐ Donnerstag ☐ Freitag ☐ Samstag ☐ Sonntag

✎ **Jetzt bist Du an der Reihe!**

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Frühstück		
		Hast Du auch nicht auf Getränke vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Vormittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Mittagessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Mahlzeit	**Ungefähre Menge**	**Lebensmittel oder Getränke**
Nachmittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Abendessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Spätmahlzeit		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Meine Mahlzeiten waren heute *(bitte ankreuzen)*

☐ wie immer ☐ anders als sonst

Besonderheiten/Bemerkungen/Sonstiges:

Angaben zum 3. Protokoll TAG 3

Datum: _____________ Ist heute ein Schultag? ☐ Ja ☐ Nein

Wochentag: ☐ Montag ☐ Dienstag ☐ Mittwoch ☐ Donnerstag ☐ Freitag ☐ Samstag ☐ Sonntag

Jetzt bist Du an der Reihe!

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Frühstück		
		Hast Du auch nicht auf Getränke vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Vormittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Mittagessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Mahlzeit	Ungefähre Menge	Lebensmittel oder Getränke
Nachmittagsjause		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Abendessen		
		Getränke und Naschereien nicht vergessen?
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	
Spätmahlzeit		
	Wo? ☐ zu Hause ☐ woanders, schreib wo:	

Meine Mahlzeiten waren heute *(bitte ankreuzen)*

☐ wie immer ☐ anders als sonst

Besonderheiten/Bemerkungen/Sonstiges:

Hier noch ein paar Tipps zum Ausfüllen des Fragebogens:

Beschreibe Deine Mahlzeiten bitte **so genau wie möglich!**
Dazu einige Beispiele:

statt Brot — schreibe Schwarzbrot, Weißbrot, Sonnenblumenbrot, Vollkornbrot, Mohnweckerl, Kürbiskernweckerl, Semmel, Kornspitz, ...

statt Wurst — schreibe Extrawurst, Leberstreichwurst, Putenwurst, Frankfurter, Tiroler Schinkenspeck, Salami, ...

statt Fleisch — schreibe Wiener Schnitzel (vom Kalb), Schweinsbraten, Grillhuhn (Keule), Putenfilet gedünstet, ...

statt Milch — Bei Milch und Milchprodukten (wie Joghurt, Käse) gibt es verschiedene Fettstufen. Wenn möglich gib diese Fettstufe an (steht auf der Verpackung), z.B. Vollmilch (3,6%), Magermilch (1%), Joghurt natur (1%), Fruchtjoghurt Erdbeere (Fasten nöm)
Vielleicht können Dir Deine Eltern dabei helfen!

statt Käse — Wenn möglich, gib die Fettstufe an (steht auf der Verpackung): z.B. Tilsiter (45% F.i.T.), Frischkäse (17% absolut), ...

Weitere Tipps:

Obst und Gemüse	Beschreibe Deine Portionsgrößen so genau wie möglich: z.B. 1 ganzer Apfel, 2 Apfelspalten, 1 Schüssel Himbeeren mittel, 6 Stück große Erdbeeren, 1 Teller Röstgemüse (iglo) klein, 6 Stück Babykarotten, 2 Stück Cherrytomaten,...
Fruchtsäfte	Genaue Beschreibung: 100% Apfelsaft, Orangennektar, ... ODER den Markennamen angeben z.B. Obi Apfelsaft
Fette und Öle	In haushaltsüblichen Maßen: z.B. 1 EL Butter, 1 TL Halbfettmargarine, 1 EL Olivenöl, 2 EL Essig-Öl-Dressing (Weizenkeimöl), ...
Kuchen	Sachertorte, Topfentorte (gebacken mit Mürbteig), Streuselkuchen, Marmorkuchen, ...
Süßigkeiten	Bitte Markenname angeben: z.B. Manner Schnitten
Zubereitungsart	Wenn möglich, gib an, wie die Speisen zubereitet wurden: z.B. Bratkartoffeln, gedünstetes Gemüse,...

Geschafft!

Vielen Dank für Deine Mitarbeit!

Herzlichen Dank auch den teilnehmenden Eltern!

Bei weiteren Fragen steht Ihnen unser Team gerne zur Verfügung:

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Annex 3: Publications with Author´s Contributions

Scientific Posters

Elmadfa I, Nowak V & Kornsteiner-Krenn M (2010) Dietary fat intake in Europe. *Experimental Biology 2010*, Anaheim, CA, USA, *Experimental Biology Meeting Abstract Supplement* **24**.

Freisling H, Nowak V & Elmadfa I (2010) Evaluating a safe strategy for food fortification: folate intake levels among adults in Austria. *Jahrestagung der Österreichischen Gesellschaft für Ernährung 2010*, Vienna.

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Heinzle C, Nowak V & Elmadfa I (2008) Der Einfluss von Mindestmengen auf den Zusammenhang zwischen Lebensmittelvielfalt und Energiezufuhr bei österreichischen Schulkindern. *Jahrestagung der Österreichischen Gesellschaft für Ernährung 2008*, Vienna, *Die Ernährung/Nutrition* **32**, 484.

Iglesia T, Nowak V & Elmadfa I (2009) Nutritional assessment and dietary habits in nursing students from spain. *19th International Congress of Nutrition*, Bangkok, Thailand, *Annals of Nutrition and Metabolism* **55, Suppl. 1**, 348.

Maierhofer K, Nowak V & Elmadfa I (2009) Zusammenhang zwischen dem Zeitpunkt des Mahlzeitenverzehrs und dem Body Mass Index bei älteren Menschen Österreichs. *46. Wissenschaftlicher Kongress der Deutschen Gesellschaft für Ernährung (DGE)*, Gießen, Germany.

Nowak V & Elmadfa I (2008) Außer-Haus-Verzehr von österreichischen Kindern im Pflichtschulalter. *Jahrestagung der Österreichischen Gesellschaft für Ernährung 2008*, Vienna, *Ernährung. Österreichische Zeitschrift für Wissenschaft, Technik, Recht und Wirtschaft* **32**, 483.

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Curriculum Vitae

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Nationality	Austrian
Date of birth	14th of November 1978

Work experience

Dates	September 2007 until present
Occupation or position held	Research assistant and lecturer in nutritional status assessment, health monitoring, and dietetics
Main activities and responsibilities	Co-worker in European Commission funded projects such as The European Nutrition and Health Report (ENHR II), Hector, and EuroFIR Design, implementation, and data processing of Austrian food consumption surveys Co-author of the "Austrian Nutrition Report 2008" Lecturer in nutritional status assessment, health monitoring, and dietetics
Name and address of employer	University of Vienna, Department of Nutritional Sciences Althanstrasse 14, 1090 Vienna, Austria. Head of Department: O.Univ.-Prof. Dr. I. Elmadfa
Dates	April 2004 – August 2007; October 2008 – February 2009
Occupation or position held	Course instructor
Name and address of employer	University of Vienna, Sports Institute Dr. Karl Lueger-Ring 1, 1010 Vienna, Austria

Education and training

Dates	October 2006 until present
Principal subjects/occupational skills covered	Ph.D. studies of nutritional sciences, emphasis on Monitoring Public Health Nutrition
Name and type of organisation providing education and training	University of Vienna, Department of Nutritional Sciences Althanstrasse 14, 1090 Vienna, Austria.

Dates	09 September 2008 – 14. September 2008
Principal subjects/occupational skills covered	Evidence-based Nutrition: From Requirements to Recommendations and Policies
Name and type of organisation providing education and training	Organized by the Department of Human Nutrition of Warsaw University of Life Sciences – SGGW, Poland and the Division of Human Nutrition of Wageningen University, the Netherlands in cooperation with EURRECA Network of Excellence
Dates	30 June 2008 – 05 July 2008
Principal subjects/occupational skills covered	Summer School on "Modern Methods in Biostatistics and Epidemiology"
Name and type of organisation providing education and training	Karolinska Institutet and Harvard University, Stockholm, Sweden.
Dates	October 1998 – October 2006
Title of qualification awarded	M.Sc. in nutritional sciences
Principal subjects/occupational skills covered	Nutritional Sciences
Name and type of organisation providing education and training	University of Vienna, Department of Nutritional Sciences, Vienna, Austria.
Dates	October 1997 until present
Principal subjects/occupational skills covered	Psychology
Name and type of organisation providing education and training	University of Vienna, Faculty of Psychology, Vienna, Austria.

Personal skills and competences

Mother tongue(s)	German
Other language(s)	English fluent in writing and speaking Portuguese fluent in writing and speaking French basic
Computer skills and competences	Good knowledge of electronic databases (MS Access), statistical software (SPSS, Stata), MS Office, graphics editing software, Webdesign (Dreamweaver, typo3)